1935

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City, County and State

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JUNE, 1935

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VOL. 66 PUBLIC WORKS No. 6

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June 1935

PUBLIC WORKS

Vol. 66 No. 6

CITY, COUNTY AND STATE ENGINEERING AND CONSTRUCTION

TABLE OF CONTENTS FOR JUNE, 1935

Editorial 21

General

The Emergency Relief Appropriations of 1935 9

Highways and Streets

Relieving Congested Traffic in Indianapolis. *By F. A. Henning* 10
Highway Bridge Eliminates Death Trap 12
Federal Aid and Secondary Road Surfaces. *By C. N. Conner* 22
Street Work Provides Unemployment Relief. *By Geo. W. Gard* 26
Sand Bituminous Road Mix Construction. *By H. C. Weathers*..... 31

Sewerage and Sanitation

Comparisons of Costs of Sewage Treatment Plants 18
Modern Centrifugal Pumps for Handling Sewage. *By M. M. Klosson* .. 19
Studies in Sewage Purifications. II. *By C. T. Butterfield* 23
The Digestion Tank 38
Elimination of Odors at Sewage Treatment Plants..... 41

Water, Light and Power

Concrete Dam Built with CWA Aid. *By A. H. Emerson* 13
Pasadena Builds Reservoir Roofs of Creosoted Douglas Fir 14
Soil Technology in Earth Dam Construction. *By C. A. Hogentogler, Jr.* 15
Improvements in Newport News Water Works System 18
A City That Got Something for Nothing. *By W. O. Myers* 27
The WATER WHEEL 34
Chloramine for Algae Growths..... 41

Departments

Timewasters 7
What's New? 42, 44
Material Prices 49
Readers' Service Section 51
The Engineer's Library 54

TIMEWASTERS:

Thrifty Sandy:

So he is designated by D. C. Elder of Marshalltown, Ia., who correctly interpreted Sandy's telegram to read as follows:

BRUCE IS HURT HE RACED A FORD HE WRECKED HER AND ALICE IS HURT TOO IN FACT SHE'S DEAD.

The ten words into which it was compressed will be found in the May issue of TIMEWASTERS.

The Man in the Black Tie:

In the April TIMEWASTERS was a real problem. The missing words as shown in italics below:

I don't like *it* said the man in the black *tie*. The *rite* is more impressive when you *inter* the body. You *retain* a *certain* feeling of solemnity. There will be a *reaction* against *cremation* when the *ceremation* is realized.

The stunt was to fill in the blanks represented by italics above. Using in each blank all the letters used in the preceding blank. We are a little in doubt about the final word. Can our readers help on this?

Ikey & Mikey:

The average rate at which Mikey and Ikey traveled through the May Timewasters was 12 miles an hour, and not 12½. A number of solutions of this were received, all correct.

Water Meters and the ERA:

Robert Hoops of New Lexington, O., and D. C. Elder of Marshalltown, Ia., were the first—beg pardon, Bob Clark was first—but they were second and third respectively, to solve the water meter problem. In all, 3838 meters were purchased, and 1230 were left on hand July 1. This was tough. Congratulations.

The Clock Strikes:

The act of striking of a clock is instantaneous. It takes 3 seconds for the clock to strike three. How long will it take for the clock to strike 12? *S. W. Jacobs.*

Hey, Garcon!

"102004180."

Johnny, what did the gentleman tell the waiter?

Utterly Foolish:

Abraham Lincoln White, having organized the Over the River Burying Society, purchased some land from a colored brother, and proceeded to organize a subsidiary company, the Heavenly Homes Cemetery. He purchased some second hand steel fence, which was in 12-foot panels. Altogether he bought 195 panels (on credit). With the temperature at 60° F. and allowing a tolerance of 1:4000 for joints, what was the greatest area he could fence with his purchase, assuming the panels could not be bent.

The problem is foolish, because there isn't any need to fence a cemetery. Those that are in can't get out, and those that are out don't want to get in.—*W. A. H.*

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A. PRESCOTT FOLWELL, *Editor* **W. A. HARDENBERGH,** *Asso. Editor*

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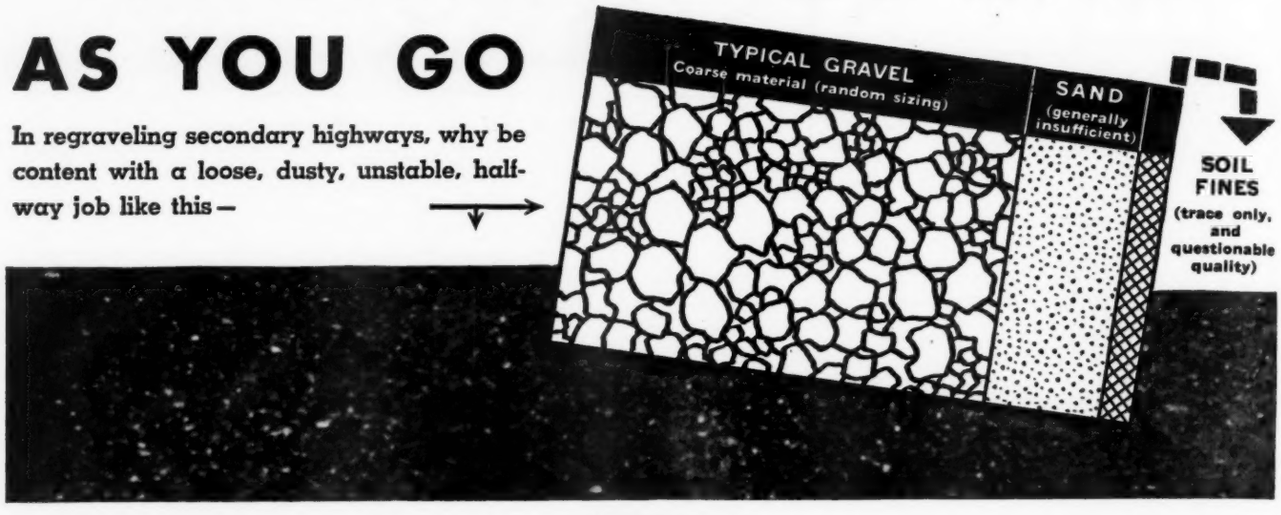
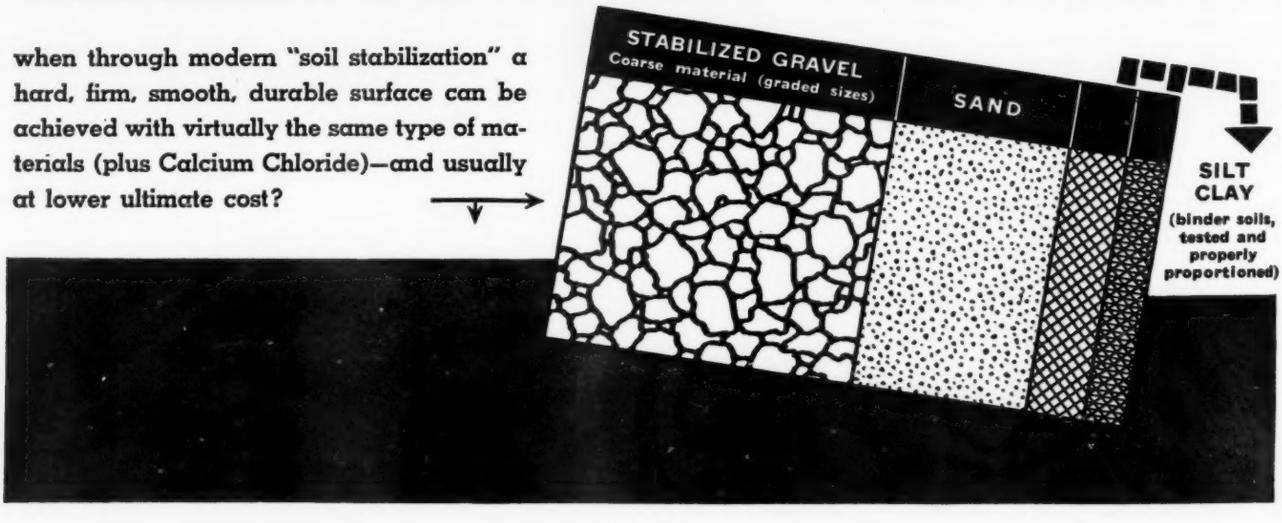


when through modern "soil stabilization" a hard, firm, smooth, durable surface can be achieved with virtually the same type of materials (plus Calcium Chloride)—and usually at lower ultimate cost?



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4 Provides all-weather stability; minimizes maintenance and material losses; produces an excellent foundation for future paving.

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PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 66 *June, 1935* No. 6

The 1935 Appropriations for Emergency Relief

AT this writing (June 1) complete information does not appear to be available regarding the terms on which the $4,800,000,000 relief appropriation will be available. Funds have been allocated along broad lines, but we do not believe that states, cities and counties know, as yet, how they will share in these monies or on what terms.

Funds Available

For highways, roads, streets and grade crossing elimination, $800,000,000 has been allocated. Apportionment for public highways will be distributed in accordance with the Hayden-Cartwright act of last year, but no part of the funds need to be matched by the states. That portion to be spent on grade-crossing elimination will be on the joint basis of population, highway mileage and railroad mileage, the last as determined by the Interstate Commerce Commission.

For water conservation, water diversion, irrigation and reclamation, and rural rehabilitation and relief, $500,000,000 has been set aside, but there is nothing available at this time to indicate what proportion will be spent purely on water supply.

For sanitation, prevention of soil erosion, prevention of stream pollution, flood control, reforestation, and other projects, $350,000,000 is provided. The type of work planned is not stated, but may include demonstration work in stream pollution control, including the complete "clean-up" of some selected watershed, such as the Potomac, the Connecticut, the Delaware, etc.

Loans and grants for states, counties, cities, etc., have been provided for with the amount of $900,000,000. This is available for street and highway work, water supplies, sewerage and sewage treatment, refuse disposal, and other work of that nature. "Self-liquidating projects of public bodies" may refer to water supply, municipal power plants or sewage projects where rentals are established.

In addition to these funds, $100,000,000 has been set up for rural electrification, $450,000,000 for housing, $400,000,000 for "white collar projects" (concerning which little is known as yet), and $600,000,000 for the CCC, which will be enlarged and expanded. This latter project may also bring some water and sewage work, since plans are under way for assignment of sanitary engineer reserve officers to this work in certain areas, with the intention of constructing reasonably sufficient facilities of this nature.

General Provisions

Preference in employment will be given to persons receiving relief, excepting those in executive, administrative, supervisory and highly skilled positions. Rates of pay will be predetermined generally for each state; the basic wage has already been announced for this. Compensation for disability and death are authorized. The FERA is continued until June 30, 1936, and the PWA to June 30, 1937. It is understood that the original stipulation that all materials and contracts are to be subject to NRA requirements will be continued.

Comments

It has been announced that the interest rate on loans will be reduced to 3%, and that grants will be increased to 45%, to induce more wide-spread adoption of this plan of providing work than resulted from the original 30-70% offer. In those communities which are not able to finance the work, and which can show real need, even these figures may be bettered. Possibly the ERA which has been extended, will be prepared to assume most or all of the burden in certain areas.

As a matter of fact, it is felt that the ERA has functioned well in many ways, and that with some minor modifications and changes, it could take up a large amount of the work of unemployment relief. Suggested modifications include:

1. A realization that recovery from the depression is not attainable with direct labor employment alone, but must utilize materials and equipment, thus improving the condition of the heavy goods industry.
2. That subsequent maintenance should be considered along with construction, and that communities should not now be saddled with structures or improvements which will produce a heavy carrying charge later. Permanent construction types are important considerations.
3. That greater attention should be given to the engineering phases of the work, and provisions made for adequate engineering staffs to plan properly, and in enough advance of the work, so that sound projects are available for construction. If this phase had been given attention previously, there would now be available any number of projects for work relief, and the relative advantages and disadvantages of these projects would have been brought out.
4. That allotments be made for approved projects, so that construction can progress in relation to the need of the work, and not be dependent solely upon the need for unemployment relief.

Relieving Congested Traffic in Indianapolis

By F. A. Henning, District Engineer
State Highway Commission of Indiana

THROUGH the assistance of funds furnished by the Federal Government and with the cooperation of the City Planning Commission of the City of Indianapolis, the State Highway Commission of Indiana adopted a new routing for a number of its highways through the city of Indianapolis for the purpose of relieving an ever increasing traffic problem in the congested business area of the city.

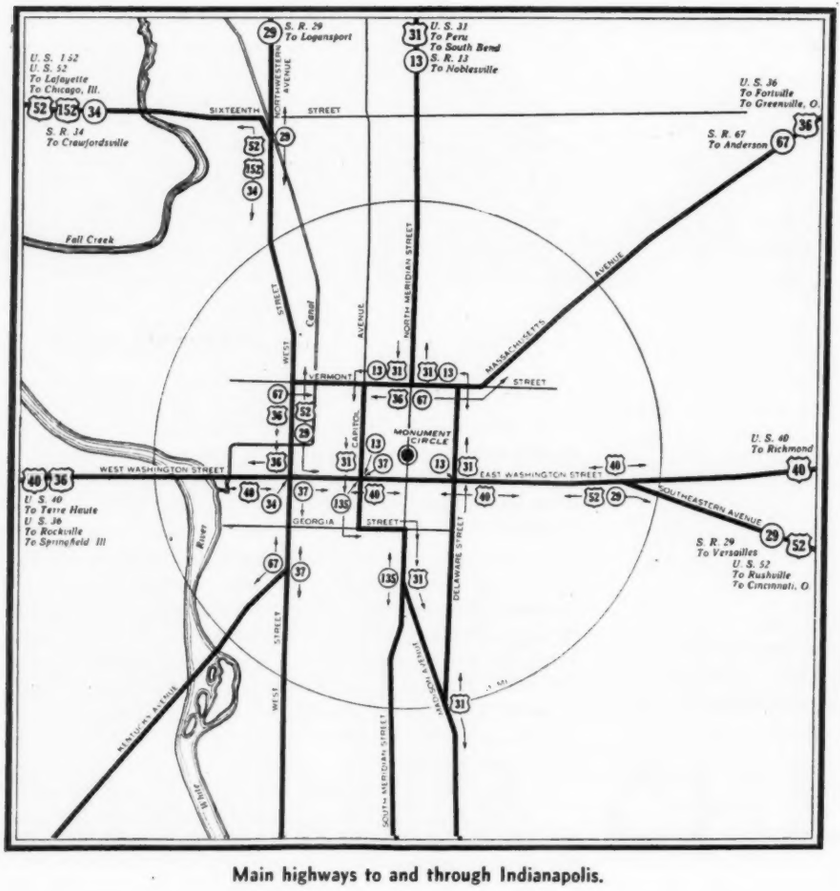
After the adoption of this new routing the Highway Commission, in the spring of 1934, began the new construction and resurfacing planned for U. S. roads 52, 152, and 36, and State roads 29, 34, 37, and 67. The plans called for approximately 121,000 square yards of concrete pavement, reinforced with 58 pounds per square yard of wire mesh, together with expansion joints and contraction joints spaced 105 feet and 35 feet, respectively; 15,000 square yards of sheet asphalt pavement resurfacing; and two major bridges and incidental construction; all of which was constructed under the new standard specifications adopted by the Highway Commission and Federal Government in the spring of 1934.

This work was let under five paving contracts and two bridge contracts, which involved the removal of a double-track street railway system on Northwestern Avenue and of the existing pavement, and the construction of a 50-ft. reinforced concrete pavement; and on West street the removal of car tracks and repaving of the car track area with reinforced concrete, resurfacing of a portion with sheet asphalt, and construction of a new 20-foot reinforced concrete pavement. The construction of a new 40-foot pavement on 16th Street, part of which was on new location, and of the two bridges mentioned, were included in this work.

The intersection of 16th Street and Northwestern Avenue centered on a canal carrying water to an industrial section of Indianapolis. In addition, on each side of and parallel with the canal were streets which entered into the design of the structure. Furthermore, the water level of the canal was approximately 3 feet higher than the adjacent streets. Due to these features, the bridge at this point is of a very unusual design. A battery of four boxes was decided upon, each box having a span of 11 feet 3 inches, the top of the boxes being the finished roadway.

The fact that the center line of the bridge is neither parallel nor at right angles to either of the streets mentioned or to the canal, together with the excessive skew of West street crossing the canal, required designing a curb acting as a beam on a 79 degree skew for the south end and a curved section for the north end.

The industrial needs of this canal made it impossible to shut off the water completely; therefore, it was necessary to construct this structure in two sections of two boxes each. By the use of steel sheet-piling a dry hole was obtained, permitting an accurate placing of the special base sections as designed. After the completion of the first unit, the canal was passed through these sections and the remaining unit constructed. All concrete was mixed at a central mixing plant, delivered in agitator trucks, and placed in the forms with bottom dump buckets operated from a stiff leg derrick mounted on track dollies and rails.



Main highways to and through Indianapolis.

On the finished roadway, due to the immense size of the intersection, it was necessary to construct two safety islands to aid in the control of traffic.

On Northwestern Avenue a 50-foot pavement was specified, laid one-half at a time and in such manner as to allow a free and uninterrupted movement of traffic on the other half. This was accomplished by the removal of one set of car tracks and the remaining portion of the pavement and curb and gutter on the side not used by traffic. A straight curb, 22 inches deep and 6 inches wide, was built adjacent to the sidewalk.

The location of the batching plant and the route of the hauling through the city presented a problem in the delivery of the material, but this was handled very satisfactorily by the adoption of a motorized industrial

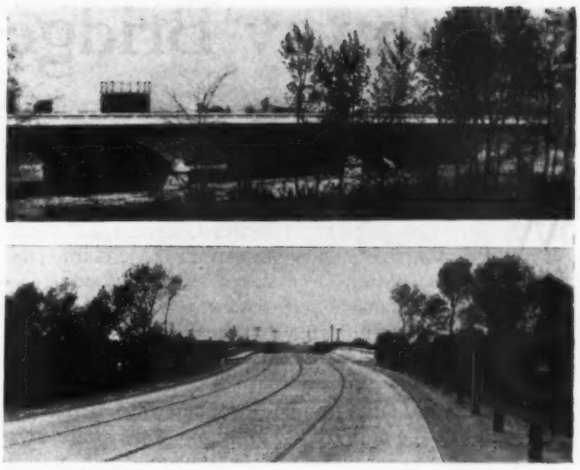
outfit. This consisted of a fleet of flat-bed tractors and trailers, carrying four or five industrial batch boxes, each batch box holding one yard. As the trucks arrived at the side of the paver they were unloaded by a small crane working independently of the paver. These units were fast, easy to handle, and kept plenty of material at the paver at all times.

On the 20-foot sections machine finishing, followed by hand floating, belting and brooming was used to finish the slab, and on the 5-foot sections a longitudinal float was used, followed by hand floating and brooming.

All expansion joints were assembled at a point adjacent to the point of placing, and carried in and installed as needed. All contraction joints and longitudinal joints were installed in grooves prepared by a mechanical device standard for this practice. The pavement was cured with wet straw. At the expiration of the curing period the completed half of the street was thrown open to traffic and the other side constructed in a similar manner.

On that part of West street where the car track area was paved, the concrete was mixed at a central mixing plant and delivered to the job in agitator trucks. Placing of the wire mats, expansion and contraction joints, and the finishing was according to the standard practice.

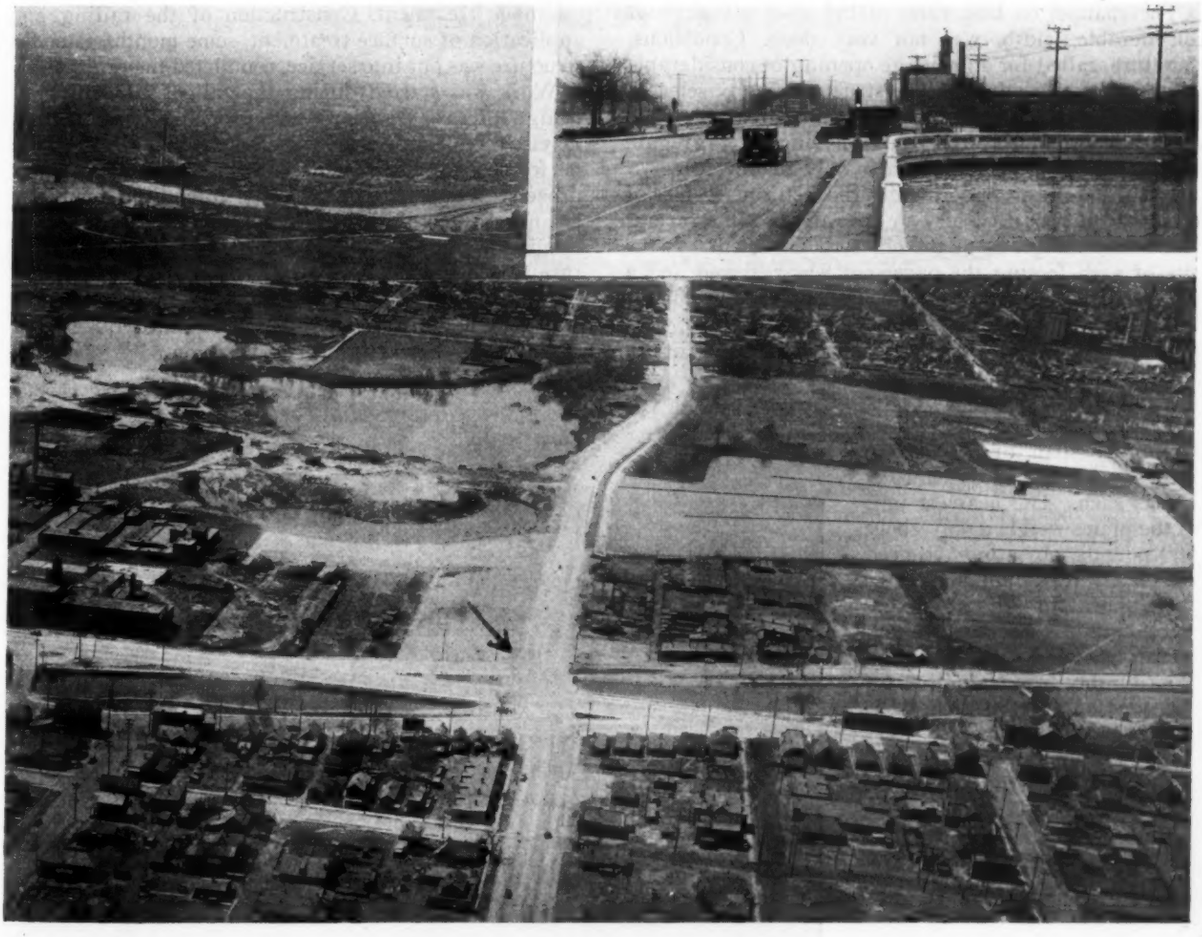
The sheet asphalt was made in a commercial plant, equipped according to the State Highway Commission standards, delivered by a fast fleet of trucks, and placed by an experienced crew of men long schooled in this line of work, all of which was responsible for the excellent results obtained.



Fall Creek Bridge. Four 72 ft. reinforced concrete arches.

By the opening of 16th street through to West street not only has the routing of the State Highways been improved but an additional cross-town street has been constructed. This was badly needed to relieve the ever-growing problem of traffic congestion in these directions.

All of the above construction, totaling approximately $509,000 was started in the spring of 1934, and all projects were completed in advance of the date set out in the contract.



Aerial view of Indianapolis showing the new 40 ft. pavement on 16th Street. In the immediate foreground (indicated by the arrow) is the intersection of 16th Street with Northwestern Ave. and the Canal. The insert shows the bridge over the canal looking along Northwestern Ave., consisting of four box culverts.

Highway Bridge Eliminates Death Trap

WHEN in 1932 the Ohio State Highway Department took over from Butler County the Excello-Trenton road, (now state route 73), it inherited a hazardous situation. For years, during flood stages of the Great Miami river, backwater had inundated this road for a considerable distance and to a maximum depth at one point of from 4 to 6 feet. Motorists, anxious to avoid a long detour and encouraged by the fordable depth of the minor dips, sometimes drove past barricades at the main depression and were swept away by the current before they appreciated the peril. Despite depth gages, warning lights, blockades, and other precautions, at least three drownings occurred at this point.

Little damage resulted to the road itself from these periodic inundations, since it was constructed as a paved ford at the low points. However, increased use of the road by non-local traffic unacquainted with the hazard, and the failure of ordinary precautionary measures to insure complete safety, demanded that the ford be sup planted by a safer type of construction. No difficulty was encountered at the minor depressions, where conventional types of small culverts were installed, but when it came to replacing the main ford an unusual situation presented itself.

The channel on both sides of the road, although of considerable width, was not very deep. Conditions, therefore, called for a drainage opening of considerable width and low headroom. The structure finally selected as most suitable for the purpose was a quadruple-span earth-filled spandrel arch bridge having an aggregate span of about 80 feet and a rise of only about 7 feet.

Even then, to provide the desired 320 square feet of waterway it was necessary to drop the flowline several feet below the grade of the old ford pavement. At the site of each footing the pavement was removed and a trench dug down into the firm undisturbed subsoil for the footing. Footings, which were of gravity type, were poured one at a time, the same forms being used for all.

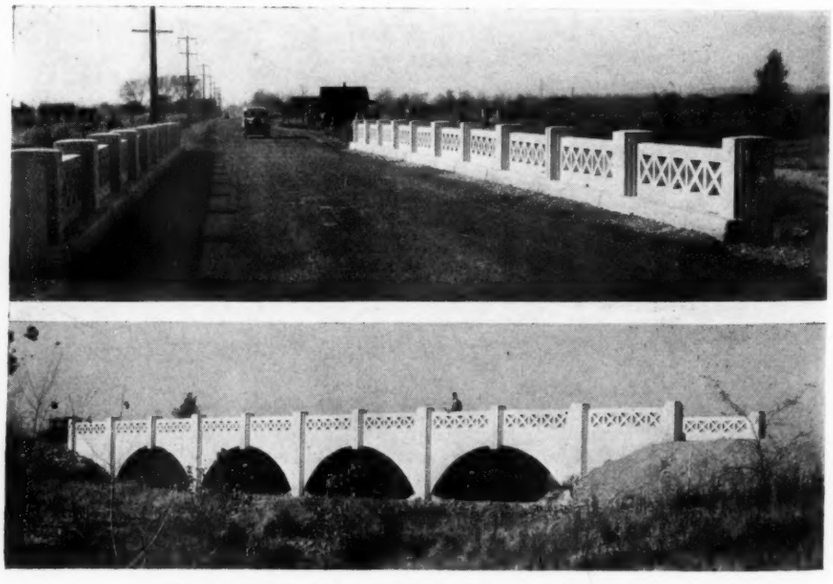
The four arches, which were exactly alike, consisted of No. 1 gage Armco Multi Plate, having a span of 19 feet 6 inches and a rise of 6 feet 10½ inches each. The heaviest unit of the plates weighed only about 600 pounds, obviating the need for handling equipment. In fact, plates for all four arches were handled and erected entirely by hand—about a full working day being required for the erection of each arch, 27½ feet long.

As a safeguard against undermining of footings, cutoff or curtain walls were constructed at the inlet and outlet ends of the arches. These walls, of reinforced concrete and carried down to the bottom of the footings, will not only minimize channel scouring but serve to tie the footings together and prevent lateral movement should undermining ever occur.

After the arches had been erected and curtain walls poured, reinforced concrete spandrel walls were constructed to withstand the outward pressure of the earth fill and to carry the railings in addition to their own considerable weight, although no support was necessary for the arches. Expansion and construction joints were provided in the spandrel walls at each pier and over the center of each arch. For additional resistance to overturning from transverse earth pressure, the spandrels were tied to each pier by means of reinforced concrete counterforts. The general modernistic effect achieved by the spandrels and railings is both unconventional and pleasing.

Before the earth fill was placed, all contact surfaces of the arches and spandrels were coated with waterproofing compound. The fill was hand-placed between the arches until sufficient depth had been obtained to provide a roadway for trucks, after which the filling operation was carried to grade with trucks. Traffic was permitted over the new structure as soon as the temporary gravel surface was in usable condition in order to consolidate the fill and get the surface ready for bituminous treatment. Construction of the railing and application of surface treatment, some months after the structure was put into service, completed the project.

Work was started during the fall of 1933 by state bridge forces of Division 8 under the direction of Homer Davis, foreman, and all work on the bridge itself was performed by these men. Grading work on the approaches was started by C.W.A. forces and completed as an F.E.R.A. project in 1934. Surface treatment was applied by regular state maintenance forces. The structure was designed by Larry Gamble, division bridge engineer, and all work on the bridge and approaches was done under the general supervision of Luke Brannon, then division engineer of Division 8.



Through and side views of bridge on Ohio State Route 73.

LeRoy concrete dam under construction. Footings in the right foreground. Bridge approach in the background. Looking east.

Concrete Dam for LeRoy, New York, Built With CWA Aid

By A. H. Emerson,
Vice-president William T. Field Engineers, Inc.

WHEN the CWA was being organized, the Board of Trustees of the village of LeRoy, Genesee County, New York, began to make plans to clean out Oatka creek which runs northerly through the village. This creek is crossed by a bridge with a 70-foot arched opening at the west side of the creek bed and a solid masonry approach or abutment about 250 feet long extending from this to the east bank.

Just north of this bridge was an old stone dam extending from the easterly abutment near the easterly bank of the creek, northwesterly, diagonally across the creek, to the head gates for an old mill race on the westerly bank. This dam backed up the water to the Clay Street bridge and formed a settling basin for material carried down stream during freshet and high water.

Material thus deposited had raised the creek bed to such an elevation, except for one or two channels, that rushes and cat tails were growing in great abundance, obstructing the natural drainage of the village, creating an unsanitary condition at times of low water, and creating an unsightly condition in the center of the village.

For years local authorities had considered clearing the bed of Oatka creek but the cost had been prohibitive. Under CWA, and with the relief load existing in the village of LeRoy as well as the town of LeRoy, the proposition became feasible The village board, with cooperation and support of the town board, engaged the William T. Field Engineers, Watertown, New York, to prepare plans and specifications for making this improvement, which were approved by the county authorities and the New York office of the CWA. As aesthetic features were of considerable importance, Mr. Flemming, landscape architect of Ithaca and Wyoming, New York, was engaged by local interests to cooperate with the engineers.

A new concrete dam, about ten feet high, was laid out just south, or upstream, of the arched opening of Main Street bridge, as a quadrant of a circle with 113 foot radius and a spillway 160 feet long. (The spillway of the old stone dam was about 100 feet long). The wing wall for about twenty feet next to the bridge is two feet higher than the crest of the dam, increasing the length of the spillway to 180 feet, whenever the water rises to an elevation of two feet or more over the spillway crest. A cutoff wall was constructed along the upstream or southerly side of the Main Street bridge, at right angles to and connected to the northerly end of the dam.

At the westerly end of the spillway and adjacent the westerly bank of the creek, two head gates were built with a gate house of rubble masonry protecting them. Along the westerly bank of the creek and extending from the Main Street bridge southerly or upstream, a masonry retaining wall was constructed up to and beyond the head gates.

To simplify construction of the dam, which was designed with a gravity section, footings were designed to extend into the rock formation at least 1 foot, and were brought to a uniform level for the length of the dam, with dowel pins extending into the bed rock as well as above the footings for the spillway and dam sections proper. In addition, construction grooves were made in the footings with reinforcing bars placed

to extend up both the down-stream and up-stream faces of the dam.

Design and construction of the dam base to a uniform level simplified and expedited placing of concrete in the dam proper, which was built in alternating sections.

Wherever feasible, hand labor was employed. However, drag lines and clam speeders were employed to much advantage. Excavation was carried to bed rock. Excavation to the original stream bed level extended up stream from the Main Street bridge, southerly and southwesterly to the Clay Street bridge, these streets being approximately at right angles to each other. Approximately 100,000 cubic yards of earth were removed and rough graded on the banks, where it can be fine graded and landscaped as desired.

Results of the improvement are gratifying. An unsightly and unsanitary condition has been cleaned up and made sanitary. When landscaped and developed it will be a work of beauty in the center of one of the prettiest villages in New York State. In achieving this end, work has been furnished to many who were in need.

Pasadena Builds Reservoir Roofs of Creosoted Douglas Fir

By Dan L. Lindsley

DURING the summer of 1934 the Pasadeno Water Department completed construction of its fourth creosotel timber reservoir roof. As is the general practice in southern California, the various water companies and city water departments build covers over their reservoirs, the primary purpose of these covers being to keep the sunlight out, thereby preventing the growth of algae. Frequently this is the sole purpose of the cover, and in such cases no effort is made to have it water-tight. In fact, open spaces are often left between the boards to permit of better ventilation and to reduce uplift in case of wind storms. In other instances the covers are made to shed water and keep out dust and dirt as well, and in these cases the sheathing is of shiplap or tongue and groove stock, covered with a composition roofing.

Wood construction has been used on practically all these covers but only in recent years has pressure creosoted lumber been adopted. There have been many instances of very short service life from untreated timber, particularly where ventilation has not been given proper consideration. The termite hazard is not severe in this type of structure, although they have been found in some instances. They are a potential hazard, however, and protection against them has been one of the reasons for the increasing use of creosoted lumber.

As an example of the short life from an untreated timber reservoir roof, the city of Beverly Hills replaced the roof on its LaCienega Avenue reservoir a year or two ago after 4½ years' service. The untreated timbers were completely destroyed structurally by decay. This was a flat roof close to the ground, the reservoir basin having been excavated and lined with concrete. Ventilating spaces considered to be adequate at the time of construction were placed around three sides and covered with wire screening. The screening was later covered with cheese cloth to keep out the hosts of small gnats that were getting through the screening and into the water. Shrubbery was planted around the structure to conceal it from view, and this, together with the cheese cloth, effectively cut off the air circulation and hastened the decay.

The city of Burbank has recently had a similar instance, and at the present time is replacing with creosoted timber most of the untreated members of a roof built six years ago. The decay was so far advanced in this case that four or five of the 4 x 12-in. timber girders had broken of their own weight and fallen into the water. A screw driver could be punched through many of the 2 x 10-in. joists. In approaching the reservoir the smell of decaying wood was very noticeable.

To avoid these troubles, the city of Pasadena has adopted a standard reservoir roof design consisting of creosoted Douglas fir timber, covered with 24-gauge galvanized corrugated steel sheets, thereby making the roof water-tight and practically dust proof. One new roof of this type is that on Sunset reservoir unit No. 2, built during the summer of 1934. This reservoir is 260 ft. wide, 520 ft. long, and 16 ft. deep, with a capacity of 9,855,000 gals. A total of 167,141 bd. ft. of creosoted Douglas fir was required for its construction. The girders were 6 x 12 in. and 8 x 12 in. on inside spans and 4 x 12 in. on outside spans. The joists, bridging, plates and sills were 2 x 8 in.; the bracing, 2 x 8 in. and 2 x 12 in.; and the studs 2 x 6 in. All treated timber was select structural grade Douglas fir with the exception of the bridging and sills, which were No. 1 common grade. The posts were dense selected all heart structural redwood, 8 x 8 in. on inside locations and 6 x 6 in. on outside locations.

The timber was treated with 8 lbs. of Grade One coal-tar creosote per cubic foot by an empty-cell process in accordance with standard specifications of the American Wood-Preservers' Association. Before treatment all pieces over 2 in. in thickness were incised, those over 4 in. in thickness being incised on four sides.

The sides and ends of the reservoir were ventilated by placing No. 4 galvanized mesh across the ends of the girders and joists. In addition, a mesh covered vent 16 in. wide was constructed along the ridge.

The roof was designed for a live load of 17 lbs, per square foot, and was also designed to withstand an earthquake shock based on 1/10 gravity which is carried to anchorage at sides of the reservoir.

The reasons for using creosoted Douglas fir, as stated by the Pasadena Water Department, are quoted as follows:

"All reservoir roofs constructed by the Pasadena Water Department in recent years have been covered with corrugated metal. This has caused all the wood structure to be subject to considerable dampness. To minimize the possibility of rot due to dampness as well as to protect against termites, in any wood near the ground, we are using creosoted Douglas fir for all roof superstructures."—*(From "Wood Preserving News" for March.)*

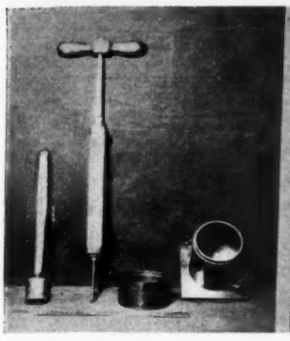


Fig. 4—Rammer, plasticity needle, and cylinder.

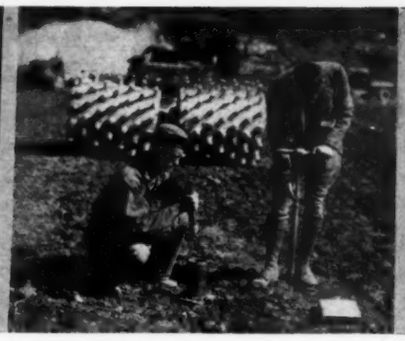


Fig. 5—Determining extent of compaction during construction.

Fig. 6—Measuring moisture content during construction.

Soil Technology in Earth Dam Construction As Employed in Back Creek Dam

Reported by C. A. Hogentogler, Jr.
Soils Technician, U. S. Forest Service

The first installment of this article, which appeared in the May issue, discussed the design features of the dam, soil examinations, and selection of materials.

Studies in Compaction

The compaction test (devised by R. R. Proctor*) discloses the moisture content at which maximum compaction can be obtained with a sheepsfoot roller during construction. The extent of this compaction is readily ascertained by testing samples at different moisture contents under the impacts of a standard tamper.

The apparatus required for the compaction test consisted of a brass cylinder 4 inches in diameter and 4½ inches deep, which is mounted on a removable base plate and fitted with a detachable collar 4 inches high to hold the loose soil in place while compacting; a 5½ pound rammer with 3 square inches end area; and a plasticity needle which measures the pressure required to force a needle of known end area into the compacted soil.

In the compaction test approximately 5 pounds of dry soil passing the No. 4 sieve is mixed thoroughly with just enough water to make it slightly damp and compacted in the cylinder in three layers, each layer receiving 25 blows from the rammer dropped from a height of 1 foot above the soil. The soil is then struck off to the level of the cylinder, weighed, and the bearing value determined by the plasticity needle by measuring the pressure needed to force a needle of known end area into the soil at the rate of ½ inch per second. A small sample of the compacted soil is oven dried to determine the moisture content.

This procedure is repeated, each time adding enough water to increase the moisture content about 1 percent, until the soil becomes very wet and there is a substantial decrease in the wet weight of the compacted soil. The effect of moisture on the compacted densities of the representative samples is shown by plotting the wet and dry densities of the compacted soil, expressed in pounds per cubic foot, against moisture content. The plasticity needle readings, expressed in pounds per square inch, are also plotted against moisture content to show the effect of moisture on bearing value.

Two curves resulting from the test, shown in figure 7, illustrate the significance of the compaction data. The "weight of dry soil-moisture content" curve discloses that for this soil a moisture content of about 19 percent is required if maximum compaction is to be obtained. The corresponding bearing value is about 1,100 pounds per square inch.

If, at the specified compaction, the bearing value of this particular soil is indicated by the plasticity needle to be higher than 1,100 pounds, the increase can be considered as only temporary if the fill is to be unprotected from water after construction. Thus, a bearing value of 1,600 pounds per square inch indicates a moisture content of slightly less than 17 percent. This corresponds to a dry weight of about 106 pounds per cubic foot. At this density the soil can take up moisture to a maximum of slightly more than 20 percent which, in turn, corresponds to a bearing value of but 600 pounds per square inch.

This explains very clearly why fills compacted to a seemingly high degree of firmness may soften and lose stability when subjected to moisture, whereas fills compacted to a somewhat less degree of firmness may retain their stability under similar conditions of moisture. It also suggests how uncertain the outcome may be when embankments are constructed with a given degree of compaction without reference to moisture content, or with a given moisture content without reference to the type or extent of compaction.

During the course of the work at the dam, some experiments were made to determine the effect of different admixtures on the compaction characteristics of fill material. Figure 8 illustrates the effect of these admixtures on the "dry weight-moisture content" curves. The effect of admixture 1 is to lower the curve and shift it to the right while the effect of admixtures 2, 3 and 4 is to raise the curve and shift it to the left. In the first case the optimum moisture content is increased and the corresponding density decreased; in the second case the reverse is true.

Some conception of the phenomenon of adsorption is necessary in order to understand the full significance of the dry weight-density curves. Such material as presented by Bancroft† suggests that all solids tend to adsorb (condense on their surfaces) any gases or vapors with which they are in contact. This adsorption is selective so that, for a liquid to wet a solid in the presence of air, the liquid must be adsorbed more strongly than the air and must displace the air. Due to adsorbed air on the surface of the solids, drops of rain, after a long period of drought, will often roll along dust without wetting it.

The second characteristic of adsorption to be kept in mind is that the properties of matter in film phase may differ widely from those of matter in the bulk phase. Thus, moisture filling the pores of sandy and silty soils and of clay soils in the plastic state has in general the evaporation and freezing characteristics and the surface tension of water in bulk. As drying or mechanical compaction increases the density of the clay, a moisture content is eventually reached at which the boiling point of the moisture, which now exists as a film, rises, the freezing point lowers and the surface tension increases so that the films become somewhat tougher than water in bulk. This moisture content is termed the plastic limit. Reduction of the moisture content below the plastic limit causes the soil to change from a plastic to a semi-solid material. In thicknesses below two-millionths of an inch the films behave, according to Terzaghi, like semisolid substances.

Very fine vapor films have an adhesive power so great that they cannot be removed from glass by heating at a temperature up to 500° C. nor from soils by forces of 9,000 to 15,000 atmospheres.

* Fundamental Principles of Soil Compaction, by R. R. Proctor, Engineering News-Record, 1933.

† Applied Colloid Chemistry, by W. D. Bancroft, McGraw Hill Book Company, 1932.

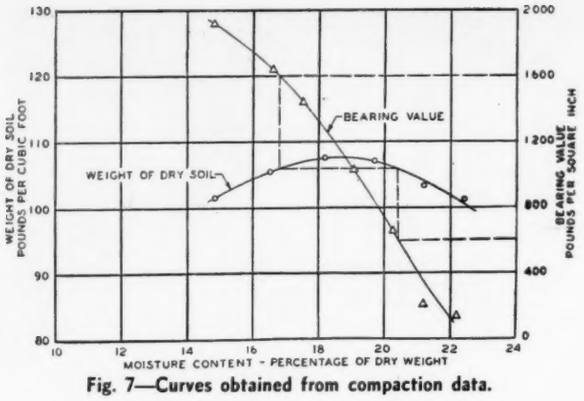

WEIGHT OF DRY SOIL - POUNDS PER CUBIC FOOT
BEARING VALUE - POUNDS PER SQUARE INCH
BEARING VALUE
WEIGHT OF DRY SOIL
MOISTURE CONTENT - PERCENTAGE OF DRY WEIGHT

Fig. 7—Curves obtained from compaction data.

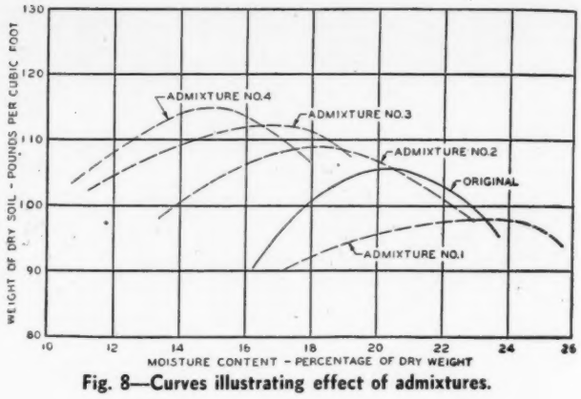


Fig. 8—Curves illustrating effect of admixtures.

Due to adsorptive attraction, moisture may enter unconfined soils and separate the particles to such an extent as to cause the soil mass to lose all semblance of stability. In confined soils the entrance of capillary moisture may be productive of enormously high pressures.

When the soil is compacted to maximum density at optimum moisture content, the adsorptive attraction between water and soil particles is probably completely satisfied so that the tendency for moisture to enter the soil and expand or soften the soil mass is largely eliminated. However, if during the process of compaction the soil grains have been placed in a condition of elastic stress, they can be expected to rebound and cause the soil mass to expand. Such tendency to expand, as well as the compressible characteristics of compacted samples under conditions of changing loads or moisture content, may be determined by testing samples of compacted soil in the Terzaghi compression test apparatus.

The relative resistance of wet and dry soil samples to the entrance of capillary moisture is demonstrated by experiments reported in PUBLIC ROADS, June 1931.

Two disks cut from each of a number of compressed soil samples were immersed in water—one in the wet state and the other after being dried to constant weight. Sixty-seven of the disks immersed in the wet state remained intact after being immersed for an average period of nine months. The corresponding disks, immersed in the dry state, disintegrated after being immersed for periods ranging from 10 minutes to 1 hour.

If then, we analyze these compaction curves from the standpoint of the theory of adsorption, we reason that admixture 1 causes an increase in the thickness of the adhesive film and, consequently, a greater degree of compaction would be required to produce the same density as that obtained with moisture without the admixture. Because of this fact, this type of admixture could not be considered as furnishing a beneficial effect. In the case of admixture 2, 3 and 4, in contrast, the effect is to reduce the thickness of the film so that, without changing the degree of compaction, a higher density is obtained with a proportionate increase in adhesive strength of the films and ultimate stability of the mixture. Or, in case the elastic properties of the soil grains are such that an increase in the density is not practical, then the use of these admixtures would allow the desired degree of compaction with less effort. From these results it seems feasible to utilize admixtures of chemical substances applied during construction to improve the characteristics of some of the poorer soils or decrease the effort required to compact soils of the better grade.

The compaction, compression and subgrade tests of these soils investigated showed that the compacted materials have low permeability and but little tendency to expand appreciably under conditions to be met in the fill. The average permeability of the compacted material was such as to indicate a flow of about 0.005 gallon per day per square foot of core wall face.

According to table I, all of the soils may be considered to have enough sand to produce stability, enough clay to bind the sand in a water-tight mass, and not enough silt to cause detrimental capillary rise. The low liquid limits for soils of this grading indicate the absence of mica, diatoms or organic matter. The plasticity indexes are high enough to indicate that the soils will not lose stability in the presence of water without manipulation. The shrinkage limits are well below the liquid limits, a condition usually met in the more stable soils. The field moisture equivalents are also well below the liquid limits, a further evidence of stability.

It is interesting to note that the optimum moisture contents of all of the soils selected for the fill were just slightly above their plastic limits. This is highly significant from the standpoint of practical construction and suggests a definite basis for the selection of dam soils. To begin with, we are concerned with the mixing water both as a lubricant and as an adhesive. Its lubricating properties control the effort required to produce a given degree of consolidation. Its adhesive properties determine the stability of the compacted soil. When the surface tension of the moisture films increases after the moisture content is reduced below the plastic limit, the lubricating properties of the films are reduced and the adhesive properties increased. As a result, the plastic limit is the moisture content of the soil, below which there is a considerable increase in the compaction required to produce a given density and also below which the stability of the soil is considerably increased.

Therefore, it seems desirable from a practical standpoint to compact the soil in the plastic state but as near to the semi-solid state as possible. Consequently it would seem that for optimum moisture contents just above the plastic limit there is obtained the most favorable balance between lubricating and adhesive properties.

If the optimum moisture content of a soil is just slightly above the plastic limit, the evaporation during consolidation will probably cause the soil to be just at or slightly below the plastic limit at the conclusion of rolling.

It appears at present that the soils most suitable for dam construction have optimum moisture contents just slightly above the plastic limit and that the difference between the plastic limit and the optimum moisture content may serve as a basis for the selection of fill soils, although more work must be done along this line before any specifications could be set up.

Control During Construction

During construction it was necessary to perform a number of tests in the field to control the moisture contents and the degree of compaction. The moisture contents were quickly determined by packing the wet soil in the Proctor cylinder, weighing, measuring the bearing value and comparing these values to the wet weight and bearing value curves for the particular sample. These values were repeatedly checked by oven-drying small samples to determine the moisture content more accurately. If the soils were found to be below the optimum moisture content, they were sprinkled with water on the fill; if found to be above the optimum, they were spread on the fill in thinner layers and allowed to dry either before rolling or during longer rolling periods.

To determine the extent of compaction, approximately 15 pounds of the compacted soil was removed from the layer by a post-hole auger and weighed on a milk scale of 30 pounds capacity. The same soil was then packed

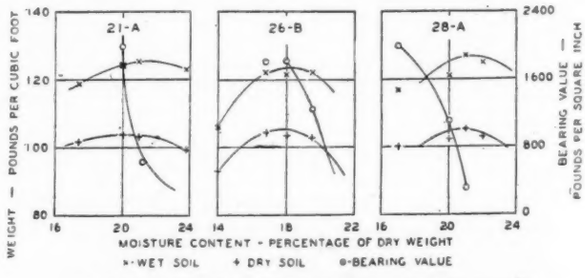

21-A
26-B
28-A
WEIGHT — POUNDS PER CUBIC FOOT
BEARING VALUE — POUNDS PER SQUARE INCH
MOISTURE CONTENT - PERCENTAGE OF DRY WEIGHT
×-WET SOIL + DRY SOIL ⊕-BEARING VALUE

Fig. 9—Compaction curves of representative samples.

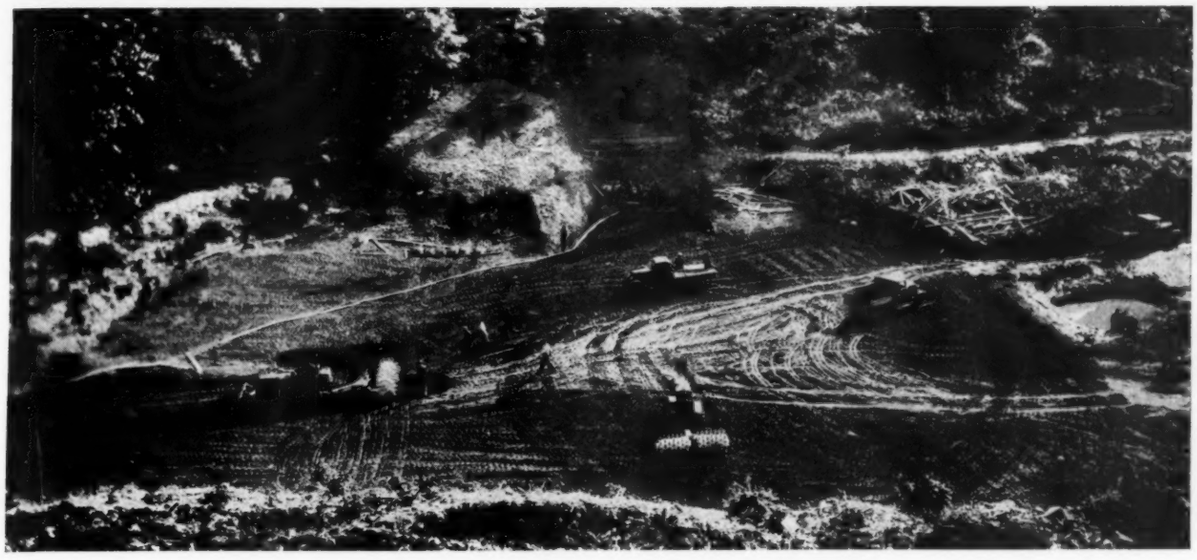


Fig. 10—Trucks and sheeps-foot rollers compacting material in dam.

in the Proctor cylinder, weighed and the density and moisture content computed as in the regular tests. The hole was filled with sand of a known loose weight per cubic foot and the volume of the removed soil computed. The wet and dry densities of the compacted material were determined from the weight, moisture content and volume. A comparison of the densities of the wet soil in place and the same soil compacted in the cylinder in the standard manner immediately indicated whether more rolling was required or whether the number of trips could be decreased.

The extent of compaction was determined more quickly by measuring the bearing value of the soil layer in place and comparing the values to the readings obtained on the same soil compacted in the standard manner in the cylinder. If the bearing values of the soil layer were less than those for the soil in the cylinder, more rolling was required. This test was not used as extensively as the dry weight test because of the presence of gravel in the material which interfered with the needle.

Construction Procedure

During construction, the stream flow was taken care of by a 36-inch metal pipe which was placed in a trench excavated to rock and was bonded to the rock by a 6-inch concrete support, concrete also being poured between the sides of the trench and the pipe, and over the top of the pipe in an arch 6 in. thick. Entrance of the water was controlled by a flood gate mounted on a tower at the upstream end of the pipe, which tower also was founded on rock. To prevent the creeping of water along this drain, several collars were added and very carefully selected material was hand-tamped around the pipe and the collars. Water was carried to the drainpipe by a trench, which intercepted the stream about 500 feet in front of the dam site.

After the stream flow had been diverted through the drainpipe and the dam site dried up considerably, the excavation of the cut-off trench was begun. The east side of the trench was dug by hand and the dirt removed by a scraper and reworked on the back of the fill. The rock foundation for the core wall was carefully cleaned, and in some cases dried by compressed air before any material was placed.

The west side was excavated by the gas shovel and the rock cleaned off by hand. When this had been finished, a number of mud seams were noticed and some of the rock was removed in an attempt to reach a more solid foundation. As no reduction in the number or size of the mud seams was noticed after two feet of rock had been removed, the excavation was discontinued but, in order to eliminate the possible washing of the core-wall material in contact with these seams, they were capped with concrete.

After the trench had been completely cleaned and dried, the placement of material was begun. The borrow pit area was first cleared of all stumps and the top soil carefully stripped off. The soil was tested for moisture content by means of the plasticity needle by the procedure outlined above and then loaded into trucks by the gas shovel and hauled to the dam. The efficiency of the shovel was greatly increased by the assistance of the trailbuilder in pushing the soil into the location of the shovel and so deepening the cut.

The material was spread on the dam in 8-inch layers, by the use of dump sticks or by the trailbuilder. The soil was compacted by means of two sheepsfoot rollers

Table No. 1—Results of Routine Subgrade Tests on Representative Samples

	Mechanical Analysis					*Constants of fraction smaller than 0.42mm.*				
Sample	*Particles Smaller Than (mm.)*					*Liquid*	*Plasticity*	*Shrinkage*		*Field Moisture*
No.	*2.0*	*0.42*	*0.05*	*0.005*	*0.001*	*Limit*	*Index*	*Limit*	*Ratio*	*Equivalent*
1-B	80	73	46	28	14	35	14	23	1.7	31
2-A	76	71	46	21	11	30	12	19	1.7	24
8-A	60	50	30	17	8	33	12	24	1.7	28
16-A	86	84	60	37	20	38	17	23	1.7	28
17-B	78	70	45	27	14	35	16	19	1.7	25
20-B	71	67	53	40	29	55	26	25	1.6	41
21-A	79	73	55	33	17	37	17	20	1.6	28
26-B	100	100	58	38	19	37	17	20	1.6	29
28-A	100	100	58	33	16	32	12	23	1.7	25

drawn by tractors. One of the tractors was equipped with trail-building equipment and was used to spread the layers. Generally eight to ten trips of the roller were required to produce the desired compaction.

The effectiveness of this method of consolidation for furnishing the soil with a high resistance to erosion was clearly demonstrated during a flood which occurred when the embankment was but partially completed. During this period, water flowed over the dam to a maximum depth of several feet for a period of several days without causing serious erosion. That the adsorptive attraction of the compacted soil was completely satisfied is indicated by the fact that moisture determinations made on the compacted soil after the flood failed to disclose any increase over that at which the embankment was constructed, except in the several inches of partially compacted material with which water was in contact.

J. C. Dort, Regional Engineer of the U. S. Forest Service, who directed the project, was responsible for the design of the dam and the methods used in its construction. John W. McNair and L. R. Strickenberg stationed at Harrisonburg and C. T. Saunders stationed at the dam site were in immediate charge of the work. Labor was supplied by the Civilian Conservation Corps Camp F-8, under command of Captain Richard Cattlet.

Preliminary investigations of stream flow and foundation conditions were made by W. B. Gallagher, consulting engineer, Waynesboro, Va. During construction the soil investigations were made by an engineer of the Forest Service stationed at the dam site. In this work the U. S. Bureau of Public Roads cooperated by furnishing engineers to assist in the field work and also by making available the testing facilities of their subgrade laboratory at Washington. The engineers cooperating in the field work were E. A. Willis and J. A. Kelley, Jr.

Comparison of Costs of Treatment Plants

AKRON, Ohio finds it necessary to increase the capacity of its sewage treatment plant, and T. C. Schaetzle, engineer-chemist in charge, has outlined a ten-year program for this purpose. As an introduction to this, E. A. Kemmler, director of public service of Akron, presents certain data to be considered in preparing such a program. These are as follows:

Cost of Operation

The selection of the type of sewage treatment plant depends largely on local conditions, such as:

1. Percentage of dilution possible in receiving body of water.
2. Nature and quantity of unavoidable factory wastes.
3. Quantity, character and strength of sewage.
4. Possible utilization of gas produced by sewage sludge.
5. Topography and land available in unpopulated areas.

In the case of expansion of the Akron Sewage Plant, any of the following types might be suitable:

1. The existing biological type, consisting of grit chamber, detritus tanks, Imhoff tanks, trickling filters, humus tanks and sludge drying beds.
2. Primary treatment followed by the activated sludge process, with separate digestion tanks and sludge beds or vacuum filters, or with sludge conditioning tanks plus vacuum filters.
3. Chemical precipitation and vacuum filters.
4. Primary treatment and intermittent sand filtration.

The *construction cost* to produce an effluent equal to or better than that from the existing plant, to treat 40 million gallons of present-day Akron sewage would be roughly:

1. Present type	$4,400,000
2. Activated sludge	3,200,000
3. Chemical precipitation	$2,000,000 to 4,000,000
4. Intermittent sand filtration	6,000,000 to 8,000,000

The *approximate cost* of *operation*, per million gallons, would be:

1. Present type (Akron—$5.00)	$7.00 (Average of 11 plants)
2. Activated sludge	*$8.00 to †$27.00
3. Chemical precipitation	8.00 to 20.00
4. Intermittent sand filtration	7.50 to 10.00

The combined cost of operation, amortization and interest at 4%, during a period of 30 years, per million gallons, would be:

1. Present type	$21.00 to $23.00
2. Activated sludge	20.00 to 37.00
3. Chemical precipitation	15.00 to 38.00
4. Intermittent downward filtration	30.00 to 46.00

*Recent Chicago estimate for very large plant (400 MGD).
†H. P. Eddy estimate for Akron in 1926.

Obviously the activated sludge and intermittent sand filtration types of treatment are too expensive to receive consideration in connection with possible expansion of the Akron plant. The modern chemical methods, with cheaper materials than were available in the pioneer days, have been introduced so recently that caution is the keynote in weighing these types against the tried biological processes, which have proven fairly successful.

The encouraging factors in the development of chemical processes are: (1) increased knowledge of sewage chemistry and its adaptability to present-day mechanical and motorized devices, and (2) the fact that the promotion of these processes is in the hands of strong corporations having outstanding technical advisers who may be expected to develop an economical and efficient process that will be dependable and possibly "foolproof." In the meantime, Akron can well await the results of these numerous studies and experiments and select the best from among those which survive the competition.

Improvements in Newport News Waterworks System

The Newport News water system is owned by the city of Newport News, operated by a commission of three appointed by the city council, and supplies approximately 70,000 consumers, half in communities outside the city east to Chesapeake Bay.

The water comes from three impounding reservoirs more than 15 miles northwest of the city; is filtered in a modern 8 mgd. plant located at one of the reservoirs and pumped into the distribution system. Recently the steam pumping plant, which had been in service almost 40 years, was replaced by 3 electric-driven pumps of 7,500 gpm. combined capacity, and a 1,000,000-gal. elevated tank was built in the northwest corner of the city, adjacent to a storage reservoir of 3.5 mg. capacity. These changes made possible a more uniform pumping rate and chemical feed rate and will effect a saving of approximately $12,000 a year in operating costs.

The new tank is on a tower 125 ft. high, and has a diameter of 84 ft. with only 25 ft. between upper and lower water levels. The bottom is of radial cone construction.

Modern Centrifugal Sewage Pumps

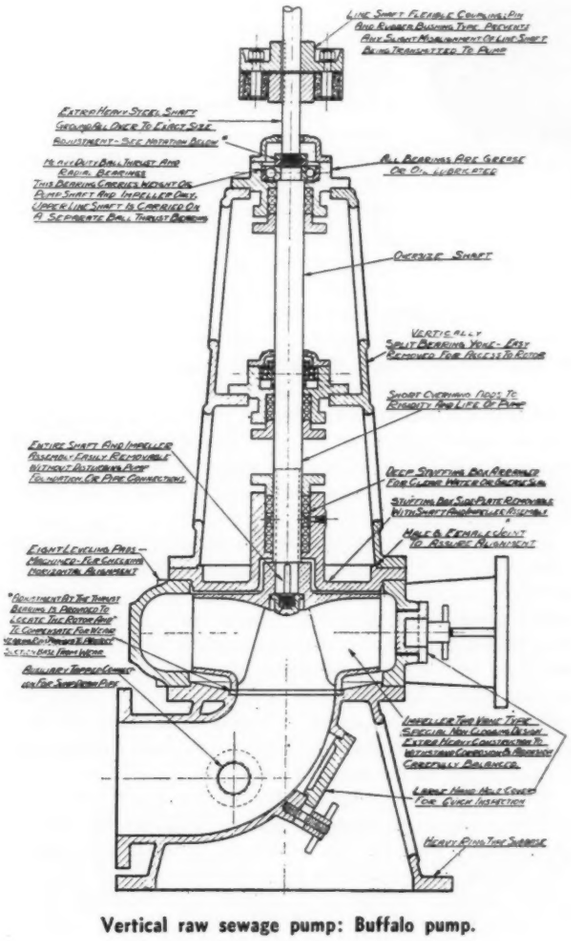
By M. M. Klosson
Chief Engineer, Buffalo Pumps, Inc.

WITH the development and modernization of sewerage systems for industrial plants, municipalities and suburban communities, there has been an equally important development in centrifugal pumps which will pass sewage sludge and similar liquids carrying solid matter in suspension.

In the selection of pumps for this service, the first consideration should be that they will handle these substances through the pump, and particularly through the impeller, without clogging. Extensive investigations and experiments have made it possible to develop pumps that can move sewage efficiently, without clogging, without excessive internal wear or mechanical difficulties.

Among these factors, reliability and freedom from clogging are the major requirements These requirements center around the design and type of impeller.

While some prefer the open type of impeller for sewage, the enclosed type is more efficient and with reasonably wide and uninterrupted passages and with impeller vanes designed to handle solids, trash and stringy material without clogging, has proven entirely satisfactory for this service. An impeller of this type should have not less than two and not more than four vanes, depending on the size of pump. The impeller vanes should be generously rounded at the inlet, designed to offer minimum resistance to flow, and the inlet otherwise so designed that stringy material such as strings and rags, which are apt to form a ball or a wad, will not clog the impeller.


Line Shaft Flexible Coupling, Pin And Rubber Bushing Type, Prevents Any Shaft Misalignment Or Line Shaft Bump Transmitted To Pump
Extra Heavy Sized Shaft Throughout Over To Exact Size Adjustment - See Notation Below
Ball Bearings Are Grease Or Oil Lubricated
Oversize Shaft
Vertically Split Bearing Yoke - Easy Removed For Access To Rotor
Short Overhung Rods To Reduce The Life Of Pump
Deep Stuffing Box Provided For Close Water Or Vacuum Seal
Stuffing Box Side Plate Removable With Shaft And Impeller Attached
Male & Female Joint To Assure Alignment
Eight Fitting Pads - Machined - For Exceptional Horizontal Alignment
Adjustment By The Thrust Bearing Is Provided To Locate The Rotor And To Compensate For Wear
Auxiliary Supply Connection For Shaft Seal Water
Impeller Two Vane Type - Special Non Clogging Design - Extra Heavy Construction To Withstand Corrosion & Abrasion - Carefully Balanced
Large Hand Hole Cover For Quick Inspection
Heavy Ribbed Type Support

Vertical raw sewage pump: Buffalo pump.

The size of maximum solids the pump must handle establishes minimum passages through the impeller and pump casing and imposes certain hydraulic limitations which have direct relation to pump efficiency. If the passages through the impeller and pump casing are too narrow, the reliability of operation is detrimentally affected; on the other hand, if these passages are excessively large the pump efficiency is reduced. Practical field experience combined with exact knowledge of engineering requirements have made it possible to produce pumps with passages so proportioned that the highest possible efficiency is obtained ***without*** clogging.

In general, the passages through the impeller and casing should not be smaller than 2″ for the smallest size of pump. Such openings are satisfactory in cases of smaller-capacity pumps where foreign solids not belonging to sewage are screened and not permitted to reach the pump. However, 2″ passages are entirely too small and involve too much risk in any system where the sewage is not screened. Whether the sewage is screened or not, small pumps, owing to smaller passages through them and due to small impeller diameter, must be given special consideration regarding the pump shaft speed. A common error, in this connection, is to select the pump for highest speed without any regard to the impeller diameter, instead of considering the impeller as the determining factor. In case of small pumps, it is necessary to select an impeller diameter that has correct ratio with inlet in order that the impeller will not be so small that stringy material and rags will wind around the outside diameter and partially or entirely close the passage.

Field experience indicates that a pump capable of passing 3″ solids is satisfactory for normal sewage installation. This is the smallest passage that should be used for a 4″ pump. For larger pumps the passages should be increased as may be necessary according to hydraulic requirements for best results. The idea of increasing the passages through the impeller with relation to discharge opening is misleading and the practice should be discouraged. Certainly, there is no hydraulic reason for designing the 10″ pump to pass 8″ solids or 12″ pump for passing 10″ solids. Such ratios between discharge opening of the pump and passage through the impeller give very poor hydraulic conditions and impose certain undesirable mechanical conditions which lead to poor efficiency and poor results

in general, especially in case of higher-head pumps.

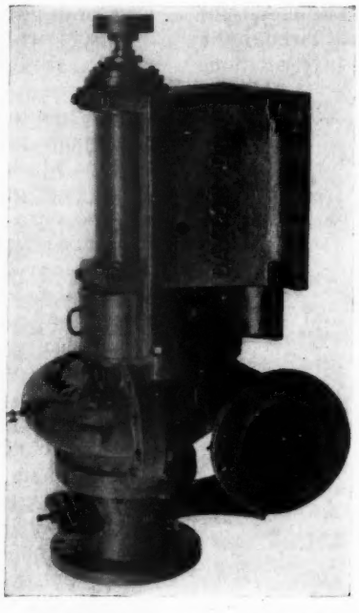
The casing of the pump is generally volute type, made extra heavy to withstand possible shocks when large solids are being passed, and to withstand the abrasive action of sand and other foreign solids. It should be provided with removable suction and stuffing box plates, machined to form a male and female fit and to facilitate alignment. The construction should be very rugged to absorb repeated shocks and other severe service conditions that exist in most sewage systems.

The casing of the pump should be provided with liberal-size hand-hole plate, so the interior of the pump can be examined quickly without dismantling the side plate or disturbing the bearings, shaft and other parts.

To avoid internal wedging action and excessive abrasive action, a liberal clearance should be provided between the impeller and the pump casing and also its side plate.

For handling raw or digested sludge, this construction must be modified to suit the density and particular character of the sludge. Also, some consideration must be given to venting these pumps in cases where a large volume of gas is carried in suspension. Since volumetric performance of a sewage pump is different when handling sludge, it is necessary to treat sludge problems separately, and for this reason this phase ot the sewage problem is not fully covered in this article.

Both horizontal and vertical pumps are used, but the vertical type is most popular where it is desired to operate the pump automatically. Usually these pumps are installed in a dry pit to keep the pump and bearings accessible. The pumps are generally installed with pump casing below the liquid level in the wet or receiving well to assure positive priming. This condition is especially essential if the pumps are operated automatically. The superstruture for housing vertical pumps is usually rather expensive and frequently horizontal pumps are used. Pumps of the horizontal type are now available with self-priming feature for full automatic operation, and it is no longer necessary to consider the more expensive excavation and buildings necessary to house vertical pumps.



Dayton-Dowd pump in vertical position.

Since the actual operation and maintenance of sewage treatment and disposal plants is to a great extent entrusted to comparatively unskilled labor, the pumping equipment must be accessible and arranged for convenience in operation, in which respect the horizontal self-priming sewage pump is admirably suited. These pumps are installed above the liquid level to permit the operator to inspect and adjust them conveniently when necessary. Self-primed pumps are available for total suction lift of 20 ft. and total discharge head above 150 ft. In some special cases higher suction lift can be met.

Since the inherent characteristics of horizontal sewage pumps are more reliable, there is less possibility of experiencing mechanical difficulties, and engineers are giving more and more consideration to the self-primed horizontal pump, fully automatically controlled.

Combined with rugged construction of the pump and impeller, it is equally important to design the shaft and locate the bearings correctly. Irrespective of the horse power, the pump shaft must be considerably oversize to absorb possible vibration and shock conditions when solids are passing through the impeller and the pump. The bearings must be of the highest-grade material, properly spaced to balance the overhung construction and reduce to a minimum any possible disturbance at the stuffing box.

The thrust due to the impeller and the pump shaft should be supported directly from the bearings, with provisions for adjusting the rotor so that correct clearance can be maintained between the impeller and the shell for operation at highest efficiency.

Due to the unusually severe service, heavy-duty type bearings should be selected with a liberal factor of safety based on 24-hour continuous operation.

The stuffing box construction and other important details of the pump must be specially designed for sewage service.

It has been demonstrated that, by proper design, sewage pumps can give reliability and life equal to that of clear-water pumps and with efficiencies that are remarkably high considering the service.

* * *

W. C. Dowd, vice-president of the Dayton-Dowd Company, advises against using sewage pumps with suction lifts. He says: In our experience, the only pumps that really clog handling sewage are those under suction lift, especially for an automatic station, because, when the units shut down, the heavy part of the sewage tends to float back into the pump and pack around the impeller and between the rings, if there are rings on the impeller. At least, they will pack in the space that acts as a closure between the suction and discharge portions of the impeller.

A vertical pump in dry pit is the best construction for sewage automatic operation, but the pump must be properly constructed for the work and instead of requiring handholes on the discharge and suction, the handhole on the suction elbow with a split casing that can be readily taken apart, just like a horizontal pump, is ideal and then, using the vertical pump, you have the best proposition for handling sewage that can be developed.

The accompanying print illustrates these points. When used as a vertical pump, we simply turn the pump up in a vertical position and use a bearing mounting, which eliminates the foot that is used for horizontal pumps, and make a combined suction elbow and base casting, which can bolt directly to the suction flange of the casing. In this position, the top half of the casing can be readily removed and the impeller and shaft removed from the casing, the same as an ordinary horizontal pump of the split casing type.

It would be well to emphasize the point raised regarding the high speeds that are used on the smaller centrifugal pumps. As a matter of fact, in general, the speeds used on all sewage pumps are too high for good service. These high speeds are leading manufacturers to making trick impellers, which will not properly handle sewage.

The Editor's Page

Welcome to a New Batch of Engineers

Four years ago there entered our many engineering schools an army of young men whose minds, undoubtedly, were filled with dreams of designing big bridges, constructing giant dams, and wide-flung railroad systems. This month the residue of that army, those spared by the depression and by the wiles of the professors, step forth—engineers. We welcome them to the profession.

They will (if they are to succeed) find that they have much to learn. It is probable that, instead of the bridge, dam and railroad work of their dreams, they will find it necessary to go into more prosaic fields. We wonder if any of them ever thought they might "come down" to designing a sewage treatment plant; or laying ordinary water or sewer lines or building an undistinguished looking street or selling water meters, or asphalt or checking up on the quantity of cement?

With apologies to Mr. Kipling, Robert Isham Randolph has written a fine "If" of engineering. We commend it to the new engineers, especially those parts relating to backbone and integrity. Those two factors are essentials of every good engineer, but he must also have sound knowledge, good judgment and a solid background of experience. An engineering school graduate may be an engineer without these, but not a good one.

With all this, we welcome them and assure them of our interest, and our best wishes.

Contract or Force Account for Highway Work?

Preliminary information from a questionnaire to a large number of county highway engineers shows that, in 1935, force account work is on a practical par with contract construction, in the opinions of 287 such engineers, located in 38 states. These opinions are based on local conditions, the size of the projects, the type of the projects and, in some cases, on state laws, which require contract work for projects of a certain size.

Of the 287 replies, 134 indicated preference for force account work, and 143 for contract work, but there were many "ifs" and "ands." We believe the information could be summarized fairly by stating that one-third of all county engineers believe force account most desirable for all types of work; almost all of the engineers prefer force account for the smaller jobs and for maintenance; two-thirds of them prefer contract construction for the larger jobs, for surfacing work, etc.

It was mildly surprising to us that the strongholds of the contract construction advocates should include Iowa, where 29 of 36 engineers voted for it; other states strongly for the contract system included Illinois, Minnesota (another surprise), and Florida. New York and Ohio were quite strong for force account work, as were Michigan, California, Kansas, Missouri, Tennessee, Colorado and South Dakota.

Pay Cuts and Restorations

Data on the restoration of pay cuts in city engineering offices have just been compiled by the editors of PUBLIC WORKS from replies which have been received from 824 city engineers. The real lucky ones comprised those 62 who suffered no cuts; next in order of fortune are the 111 where cuts have been restored in full; and then the 141 whose cuts have been restored in part. Last of all are the unfortunates, 395 in number, who were cut in pay and have not yet received any increase. The remaining 115 were paid in fees or percentages, or did not answer the question fully or clearly.

Another question asked had to do with the design of water department installations. In few municipalities is the water department equipped to make the surveys, prepare the plans and drawings and write the specifications for construction of pumping stations, pipe lines and purification plants. Of the 824 cities replying to this question, 608 had municipal plants, 127 reported private plants and 89 did not answer the question. In the 608 cities with municipal plants the city engineer's office prepared plans and specifications for water department work in 420, while in 188 cities the work was done by the water works superintendent or by a consulting engineer.

That this type of work is being done by city engineers in about 70% of the cities is rather surprising. Yet it is but another illustration of the importance of the city engineer and of the all-around ability of most of them to handle many and diverse types of work.

A New Edition of the Sewage Works Manual

Three years ago we began publishing a series of articles entitled "Mechanical Equipment in Sewage Treatment Works," which received so much approval by engineers that, at the suggestion of a number of them, we republished the articles in book form. This has been used as a reference book by a great many —perhaps most—of the engineers who have designed sewage treatment plants since then, most of the leading consulting sanitary engineers having expressed their approval of it; and five engineering schools already have adopted it for their classes in sewerage.

In the two years since it appeared, the entire edition has been exhausted, and several hundred orders have had to go unfilled. Also, considerable progress has been made in the development of equipment offered for this purpose as well as in treatment processes themselves. For these reasons we have decided to publish a second revised edition, (to be ready in July) and during the past two months have been examining the entire field to obtain all the latest information on the subject. All the chapters are being rewritten, and new ones added on Laboratory and Operating Apparatus, Special Construction Materials, and a final one on miscellaneous matters—grounds and buildings, etc., and general discussion of selection of equipment. The new chapters resulted from suggestions of various engineers.

A large variety of uses were discovered for the first edition of this manual. One consulting engineer reported that it provided a handy reference for presenting the features of the different types of equipment to his clients. Another said it was especially useful in office discussions leading up to the selection of equipment. Others found it very convenient in showing the younger engineers what is available in sewage works equipment and in reviewing the field themselves.

Federal-Aid and Secondary Road Surfaces

By C. N. Conner
Senior Highway Engineer, Bureau of Public Roads

THE extension of Federal Legislation to include the improvement of secondary or feeder roads has been one of the important facts in secondary road construction. Following this, the Bureau of Public Roads has set up certain design standards and classifications, which are of interest and value to engineers.

The terms "secondary" or "feeder" roads does not imply that such roads are of minor importance; rather it means that such roads are not on the Federal-aid system. Where the mileage of the state highway system is only a small part of the total highway mileage of the state, the improvement of such secondary or feeder roads is not confined entirely to the designated state highway system.

Design Standards

It is not the policy of the Bureau to require a higher type of surface than is reasonably necessary for the volume and weight of traffic to be served. Where conditions justify, therefore, projects are approved for grading and draining and for the construction of surfaces of local material, such as sand-clay or gravel. The oiling or processing of roads already surfaced with untreated gravel or similar materials for other than dust-laying purposes constitute acceptable secondary or Federal Road projects, provided that such roads meet the approved standards of design for right of way, cross section, alignment and grade. The following minimum standards of design apply to secondary roads of local importance:

Adequate widths of right of ways.

Natural rolling grades consistent with reasonable safety and an easy-riding profile.

Adequate cross road and side road drainage.

A graded width of roadbed in easy topography, of not less than 26 feet out to out of shoulders; and in rougher topography 24 feet out to out of shoulders, with an absolute minimum width of grading of 20 feet over all in mountainous country.

An alignment involving no sharp turns and other features likely to be dangerous for the anticipated volume of traffic.

A minimum surfacing width of 10 feet for single track roadways, a minimum of 14 feet for an estimated maximum of daily traffic of 250 vehicles; and a minimum of 16 feet for an estimated maximum traffic in excess of 250 vehicles.

Unless stage construction is contemplated, some type of surfacing in addition to grading and drainage is required where necessary to secure a usable improvement. The graveling or surfacing of roads previously graded by a State or county is acceptable.

Limitations Surrounding Secondary Road Funds

With respect to the use of these funds the following statements should be specially noted:

That they may be used for construction or reconstruction purposes only. They are not available for maintenance and repair work.

That the appropriation is for employment purposes, so that in the selection of projects consideration must be given to relative employment needs.

That transportation needs as well as employment needs be considered in selecting projects, so that the improvements may benefit the greatest number of people.

Particular attention is directed to the fact that Federal highway funds cannot be used for maintenance and repair work. The term "maintenance" as used in Federal highway regulations means the constant making of needed repairs to preserve a smooth surfaced highway. The clearing of ditches with graders, the filling of mud holes, the blading of existing roads, and the renewal of bridge stringers and floors are types of work which, while highly desirable, would properly be classed as maintenance and repair and ineligible for the expenditure of Federal Public Works highway funds.

Tentative Classification of Bituminous Surfaces

Of real use to engineers, highway contractors and material producers is the tentative classification of bituminous wearing surfaces set up by the Bureau. This important classification was undertaken to establish a basis of competition between wearing surfaces without classifying such surfaces with respect to their nature and resultant composition. The classification covers 10 groups of bituminous surfaces extending from Bituminous Surface Treatments designated as Class A up to Sheet Asphalts designated as Class J. Following is the list of classes:

Class A. Bituminous Surface Treatments.
Class B. 1. Road Mix Surfaces with Slow Curing Binders.
2. Plant Mix Surfaces with Slow Curing Binders.
Class C. 1. Road Mix Surfaces, Dense Graded Aggregates.*
2. Road Mix Surfaces, Open Graded Aggregates.†
*(Emulsified or Cutback)
†(Asphalt or Tar Binders)
Class D. Penetration Macadams (Asphalt or Tar).
Class E. Modified Penetration Macadams.
Class F. Plant Mix Surfaces, Open or Dense Graded Aggregate.
Class G. Rock Asphalts.
Class H. Coarse Sized Open Graded Bituminous Concretes.
Class I. Coarse Sized Dense Graded Bituminous Concretes.
Class J. Sheet Asphalts and similar types.

The classifications, and basis of competition between classes in the foregoing list are predicated upon specifications for the various types meeting the requirements of these classifications. Practically all of the proprietary and non-proprietary types having proved value are included in this list.

The classification should be especially helpful in the preliminary planning, in regard to pavements suitable for the projects under consideration.

This article is based on a paper by Mr. Conner before the American Road Builders' Association.

Studies of Sewage Purification

A Zooglea-Forming Bacterium Isolated from Activated Sludge

By C. T. Butterfield

Principal Bacteriologist, Stream Pollution Investigations, U. S. Public Health Service, Cincinnati, Ohio

This is the second and final installment of Mr. Butterfield's report. The first, in the May issue, dealt with previous studies of zooglea and the methods employed in isolation.

SUMMARY. Zoogleal masses have been observed in every good activated sludge examined. This conforms with earlier reports in the literature.

A zooglea-forming bacterium has been isolated in pure culture from activated sludge.

This bacterium in pure culture, both in synthetic media and in sterilized sewage, has produced a floc which simulated activated sludge.

This pure culture floc has been shown to remove during a 3-hour aeration period from 41 to 84 percent of the oxidizable material present in polluted water.

The morphological, cultural and physiological characteristics of this bacterium are given in detail.

This organism is tentatively identified as a variety of Zooglea ramigera as described by earlier workers.

It is suggested that an adequate knowledge of this and related organisms may be of considerable significance in sewage purification processes depending on biological activity.

MORPHOLOGICAL. This organism is rod-shaped, average length 3 microns, varying from 2 to 4, average diameter 1.5 microns, varying from 1 to 2, with definitely rounded ends. In liquid media it shows a marked tendency to grow in a floc or zoogleal mass manifested either as a loosely bound floc, as a dense, spherical mass, as an evenly lobed mass, or as a fingered tree-like floc. When found outside the mass it usually occurs singly, occasionally in pairs or in fours joined end to end. Capsules were always observed when stained by the method of Anthony (1931). The capsular wall was from one to one and a half times as thick as the bacterium. Spores are not produced as none have been observed microscopically and no growth was ever obtained after application of the heat test. When not embedded in a zoogleal mass, individual organisms are very actively motile. Chains of two to four are motile but not as active as individual cells. The bacterium possesses a single polar flagellum about 5 to 6 microns long. This character as demonstrated by the staining method of Gray (1926) is shown in Figs. No. 8 and No. 9. Although the usual variation in the size of cells was noted, irregular or involution forms were not found in the cultures examined. The organism was not observed to retain Gram's stain at any stage of culture.

Cultural. No growth of this organism has been obtained at any time on standard agar or gelatin. Scanty growth was obtained on a special sludge agar and a moderate growth on nutrient agar containing 10 percent ascites fluid. It grows well at both 20° and 37°C. in nutrient broths containing peptone, producing a flocculent growth with an abundant sediment which is flocculent to granular. As a rule the broth without the flocs remains clear and is free from odor. Broth with an initial pH of 7.0 to 7.2 has invariably become more alkaline as growth progresses until in 5 days at 37° and in 10 days at 20° a pH of 8.2 to 8.4 is reached. It grows luxuriantly in sterilized sewage under aeration, producing a flocculent sludge which settles rapidly when the agitation is stopped. The alkalinity of such sewage is increased until a pH of 8.6 to 8.8 is reached.

Physiological. A slow growth of this organism has been observed at temperatures as low as 4°C. Most vigorous multiplication occurs between 20° and 37°C., with the optimum temperature approximately at 28° to 30°. Growth takes place over a pH range of 5.6 to 8.5. However, the rate of growth at the lower figure is very slow until the pH has been raised by the products of growth. The optimum pH appears to be at about 7.0 to 7.4. No evidence of pigment production has been noted. Indole is not produced in either peptone or tryptophane broth. These tests for indole were made at 2 and 10 days, using the technique of both Bohme (1905) and of Gore (1921). Hydrogen sulphide was not produced. The organism is a strict aerobe failing to grow, during a 10-day incubation period, in vacuo or when the oxygen of the air has been replaced by nitrogen. The organisms subjected to such anaerobic conditions for 7 days were not killed, however, for when half of the cultures were removed and placed under aerobic conditions growth occurred within 24 hours. Tests were made on the ability of this organism to ferment glucose, levulose, lactose, sucrose, maltose, mannite, innulin and xylose when present in standard broth and in peptone-free synthetic media. No growth was observed in the synthetic media. Good growth occurred in the presence of each of these sugars in nutrient broth. No gas was produced in any instance, and as evidenced by changes in the hydrogenion concentration, no acid was produced from any of these sugars. However, acid may have been produced and neutralized by the by-products of growth, for as has been noted previously this organism produces alkali in nutrient broth until a pH of about 8.3 is reached while in these sugar broths a pH of 7.7 was the maximum reached in all cases after 10 days.

The survey made of the literature has not revealed a definite description of an organism with the characteristics of this zoogleal bacterium. However, regardless of the fact that this organism may manifest a growth formation of dispersed single cells, of loosely bound flocs, or of dense spherical and lobed masses, depending

on various factors, the peculiar branched tree-like form of zoogleal growth assigned to Zooglea ramigera by Flügge together with the illustration given by him is most unusual and is, under certain conditions, a characteristic of the organism described here. While such limited information as this is too meagre to warrant any attempt at the classification of an organism with ordinary characteristics, it is believed, in the case of this bacterium with this peculiarly shaped colonial form in liquid media, that this one characteristic is almost sufficient for identification. For this reason this zoogleal organism, which has now been somewhat more fully described, is tentatively assumed to be a variety of the Zooglea ramigera, named by earlier workers, until further studies may confirm or disprove this belief.

Experimental Results

With Synthetic Media. Experiments were instituted now with this zoogleal organism Z-1, to determine whether it would produce a sludge under conditions of activation and the properties of such sludges if any were produced. These tests were carried out under aseptic conditions and with reproducible synthetic media to eliminate as many variables as possible. Dilute standard lactose broth prepared by diluting 6 cc. of broth to 100 cc. with dilution water was used as synthetic media. Such media have a 5-day biochemical oxygen demand of about 300 parts per million simulating in this respect a fairly strong domestic sewage. Sterilization by autoclave was carried out in containers, put up with the necessary air-filters and appliances to provide for continuous aeration under pure culture conditions.

Preliminary trials made with this set-up disclosed that a good sludge floc was formed under conditions of very moderate aeration but when air was applied at a normal rate the floc tended to break up and become dispersed. This, in connection with the observed make-up of normal activated sludge flocs, appeared to indicate the need for some inert foreign substances to act as a binder or framework for the floc. A number of substances were considered for this purpose. Very short cotton fibers and asbestos fibers were selected for trial because of their inert character. Initial tests with these materials showed that the zoogleal bacteria would develop rather tenacious flocs adherent to cotton fibers but they would not adhere to asbestos fibers under any of the conditions tried.

The aeration apparatus was then set up with the synthetic media prepared with the addition of about 0.2 gram of short cotton fibers per liter of media. It was inoculated with the zoogleal organism and aerated continuously. After 48 hours a definite floc formation was observed. Thereafter, during the course of these tests this floc was allowed to settle for 30 minutes twice daily. At each settling two thirds of the contents were siphoned off as supernatant and were replaced with a like amount of the original media. This process was continued until a sludge of 2000 p.p.m. or over, measured in terms of suspended matter, had been developed. This sludge settled rapidly with a sludge index of 15 to 20 (15 to 20 percent of the sewage sludge mixture) at the end of 30 minutes settling.

Tests were then made on the capacity of this sludge to remove oxidizable material from solution. This observation was made by taking first a sample of the supernatant for a biochemical oxygen demand determination, immediately after fresh media had been added and thoroughly mixed. The mixture was then aerated for a 3-hour interval and a sample of supernatant was removed for a second biochemical oxygen demand determination. The difference between these two oxygen demand results should represent any changes which had occurred in the supernatant during the 3-hour aeration period. That is, if any oxidizable material had been removed from the supernatant by aeration of the media with the sludge, the oxygen demand of the second sample should be correspondingly reduced. To avoid the errors of unbalanced biological activity, which are frequently encountered when sterile or pure culture samples are put up for oxygen demand determinations, these samples were heavily seeded with a grossly mixed culture of bacteria and plankton. Each pair of samples was seeded with the same mixed culture and to the same extent.

Five such tests were completed with this experimental set-up. The amount of oxidizable material removed during the 3-hour aeration interval as indicated by the biochemical oxygen demand determination was for the five tests: 75, 76, 66, 68 and 73 percent respectively.

Control experiments using the same synthetic media containing cotton fibers, with non-zoogleal bacteria present and without bacteria, were carried on at the same time and under the same conditions. No sludges were developed either with or without bacterial growth. The cotton fibers under these conditions did not settle materially during a 30-minute period. In the series with bacteria, Bact. aerogenes was introduced and other bacteria from the air gained entrance. A very marked bacterial growth developed. However, oxygen demand determinations on samples collected before and after a 3-hour aeration period, after fresh media had been added as in the test series, did not in any instance show that any appreciable amount of oxidizable material had been removed. In fact, the removal indicated did not exceed 5 percent in any test.

The results show definitely that under the conditions of these tests the activated sludge formed by this zoogleal organism is a potent factor in the removal of oxidizable material from solution, removing an average of 72 percent during a 3-hour period. This is very greatly in excess of the amount that could be oxidized during such an interval by the usual biochemical process.

With Sterilized Sewage. The tests described above, conducted with synthetic preparations are subject to the criticism that the media did not correspond to sewage and that the zoogleal sludge formed may have been peculiarly adapted to adsorb ingredients of the synthetic media. To meet such criticism and to more closely simulate the conditions in a sewage plant, in the tests which follow, a change was made from synthetic media to natural sewage.

To maintain pure culture conditions which are essential if the results obtained are to be ascribed solely to the activity of the zoogleal bacteria, it was necessary to sterilize the sewage prior to use. Sterilization by chemcial means was not suitable as any substance which would adequately sterilize the sewage could not be removed completely. Sterilization by filtration was not satisfactory for not only would the sewage be materially altered by such filtration, but also it would be impossible to state positively that all biological elements had been eliminated. Sterilization by heat was adopted, therefore, as the most satisfactory procedure. Catch samples of domestic sewage were collected from day to

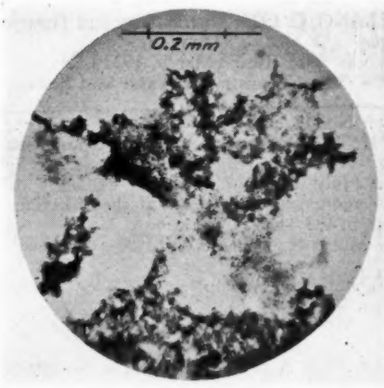


Fig. 7—Activated sludge developed by zoogleal bacteria in pure culture in sterilized sewage.

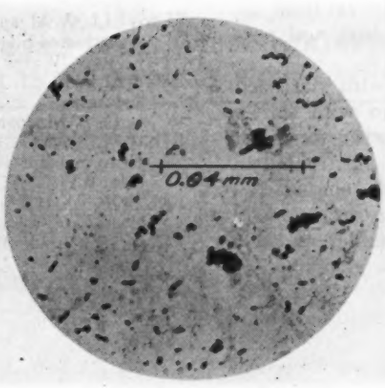


Fig. 8—Zoogleal bacteria. Flagella stain of thick smear.

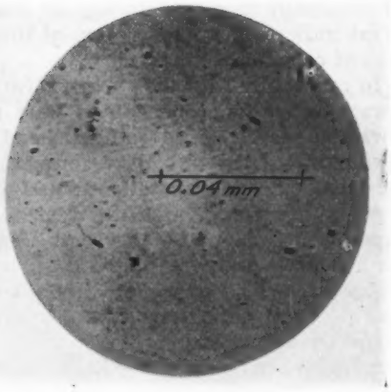


Fig. 9—Zoogleal bacteria. Flagella stain of thin smear.

day and autoclaved for the media in the tests made. The strength of this sewage varied greatly, but a large enough sample was collected each time so that all units of a series, including the controls, could be started or dosed with identical media. This autoclaving of the sewage consistently shifted the hydrogen ion concentration from about pH 7.2 to about pH 9.0. The sterilized sewage was adjusted always to pH 7.0 with sterile 1:10 phosphoric acid before use.

Using such sterilized sewage as media in eight liter amounts and sterile apparatus designed to permit aeration under aseptic conditions, four sludges were developed. A good floc simulating activated sludge began to appear after 48 hours aeration. Thereafter, during the course of the tests, five liters of supernatant, after 30 minutes settling, were removed daily, (with the exception of Sundays) and a like amount of sterile sewage was added. After about two weeks a sludge of 2000 p.p.m., which settled rapidly with indices between 15 and 20, had developed. Biochemical oxygen demand tests to determine the amount of oxidizable material removed from the supernatant during a 3-hour aeration interval after additional sterile sewage had been added were made in each case. The results showed that 68, 76, 66 and 64 percent (average 68 percent) respectively, of the oxidizable material in the supernatant had been removed.

In one container of this series after the tests had been completed, the mixture was divided into two parts, maintaining pure culture conditions, and an inoculation of a bacteria-free protozoa culture, Colpidium, was made into one of them. Both parts, thereafter, were treated in the same manner and the supernatant was replaced with fresh, sterile sewage daily until the Colpidium had reached their maximum number. Oxygen demand tests were then made on the supernatant before and after a 3-hour aeration period. The tests showed that the percentage of oxidizable material removed by the zooglea plus Colpidium mixture was only slightly greater than that obtained with the zooglea only sludge. However, the supernatant from the zooglea plus Colpidium aeration vessel was much clearer. Microscopical examinations showed that the majority of the free-swimming bacterial cells and the zooglea of microscopic proportions had been cleared from this effluent.

These observations with sterilized sewage as test media were repeated. In this set up zoogleal cultures, Z-1 and Z-3, were both used. A separate container was employed for each culture. A sludge of good appearance had developed in each after 3-days aeration. Thereafter, 5000 cc. (out of 8000 cc. total) of supernatant were withdrawn daily and replaced with sterile sewage. After 10 days sufficient sludge had developed to begin observations. A photomicrograph of this sludge is shown in Fig. No. 7. In this series, suspended solids and oxygen demand observations were made on all samples collected both before and after the 3-hour aeration period. Occasional observations were also made on the nitrite and nitrite content of the aeration mixtures. No material change in the amounts of either of these substances present was observed. This would suggest that this organism did not oxidize ammonia to nitrites or nitrites to nitrates. The results of this series of tests are presented in Table No. 1.

TABLE NO. 1

Data Concerning Activated Sludges Developed by Zooglea Cultures Z-1 and Z-3

	Suspended Solids P.P.M. Sample Collected		*Changes During 3-Hour Aeration Period*	
Culture	*Before Aeration*	*After Aeration*	*In Suspended Solids*	*In % Oxidizable Material Removed from Supernatant*
Z—1	1600	1800	+200	69
Z—1	4100*	3776	—324	41
Z—1	6512	7032	+520	71
Z—3	1810	2333	+523	57
Z—3	2248	2520	+272	68
Z—3	4528	4712	+184	56

* A large dense particle of debris was observed in this crucible after the weighing had been made.

After these tests had been completed a mixture of Z-1 and Z-3 sludge was divided into two parts. One was inoculated with Colpidium and both were continued in regular operation until the Colpidium had reached a number of 53,000 per cc. A test was then made to determine the amount of oxidizable material removed during a 3-hour aeration interval. In this instance the zooglea plus Colpidium sludge was more effective, removing 84 per cent while the zooglea alone removed 65. It was again observed that the supernatant from the Colpidium-containing mixture was much clearer.

The results given in Table No. 1 indicate again that a large amount of the oxidizable material in the added sewage is removed by the zoogleal sludge during a 3-hour aeration period. In addition it is noted in 5 out of 6 of the suspended solids tests made in this series

that the weight of the sludge in terms of suspended matter materially increased during the 3-hour aeration interval indicating an adsorption of dissolved and perhaps of colloidal material.

In connection with these experiments with sterilized sewage as media, control tests were run with sterile sewage under aseptic conditions and with sterilized sewage inoculated with Bact. aerogenes and treated in the same manner as those inoculated with zooglea. Before and after observations were made on these control experiments, only after they had been under aeration for a number of days and the Bact. aerogenes had developed fully. The results of these control tests showed that no oxidizable material was removed during a 3-hour period either in the sterile container or in the vessel containing Bact. aerogenes. In one instance a 7 percent increase in oxidizable material was observed and in another a 5 percent decrease. These amounts are well within the limits of error for an individual determination of this type.

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Street Work Provides Unemployment Relief

By Geo. W. Gard
Asst. Engineer

LEXINGTON, Kentucky, street paving for 1934, with which this article deals, was greatly overshadowed by the extensive P. W. A. Sewer Program which will be treated separately. However, considerable street paving was accomplished under our C. W. A. program, and as otherwise hereafter stated.

Where streets were improved by C. W. A. labor, the city furnished all necessary material and equipment, and for obvious reasons the city concentrated on type and methods involving minimum material costs.

The type of construction usually consisted of macadam streets with heavy rock base and cold-patch surface. The rock for this work was obtained from the city-owned quarry, quarried by C. W. A. labor. In some cases on secondary and outlying streets which had no curb, and on which narrow macadam paving had been laid on ungraded surface, rough stone curb was used and the streets were constructed to a wide uniform grade before paving. While this type of construction is neither permanent nor satisfactory for main thoroughfares, the results were quite remarkable, especially on streets where open gutters existed and where permanent paving by direct assessment at this time would be prohibitive.

From the standpoint of service to the general public, perhaps, the greatest improvements in street construction under the C. W. A. Program consisted of widening several important streets for widths varying from five to twenty-two feet, in which cases new concrete curb and sidewalks were constructed. When the reconstruction of such streets by permanent repaving shall be undertaken, the advantage of this previous widening will be important.

Where streets were torn up by reason of sewer construction, they were repaved by permanent reconstruction, the repaving being included in the sewer contracts, and for a combined distance of approximately a mile and a quarter such repaving covered from one fourth to one half the width of the street, and in one instance the entire street was repaved for one city block. It so happened that the repaving done in connection with the sewer work was on streets where such repaving is a marked improvement rather than a mere replacement.

Two Federal Aid Highway Projects within the city limits were undertaken and completed by the State Highway Department in 1934, at a total cost of $107,000, including cost of right of way, which was borne by the city at an expense of $30,000. One of these projects consisted of the opening and paving of a new thoroughfare for a distance of one half mile, eliminating two main line, double track, grade crossings on U. S. Highway No. 60 and making accessible territory with both street and railroad connections. The other project consisted of paving 1600 feet of U. S. Highway No. 60. Both projects were paved with concrete.

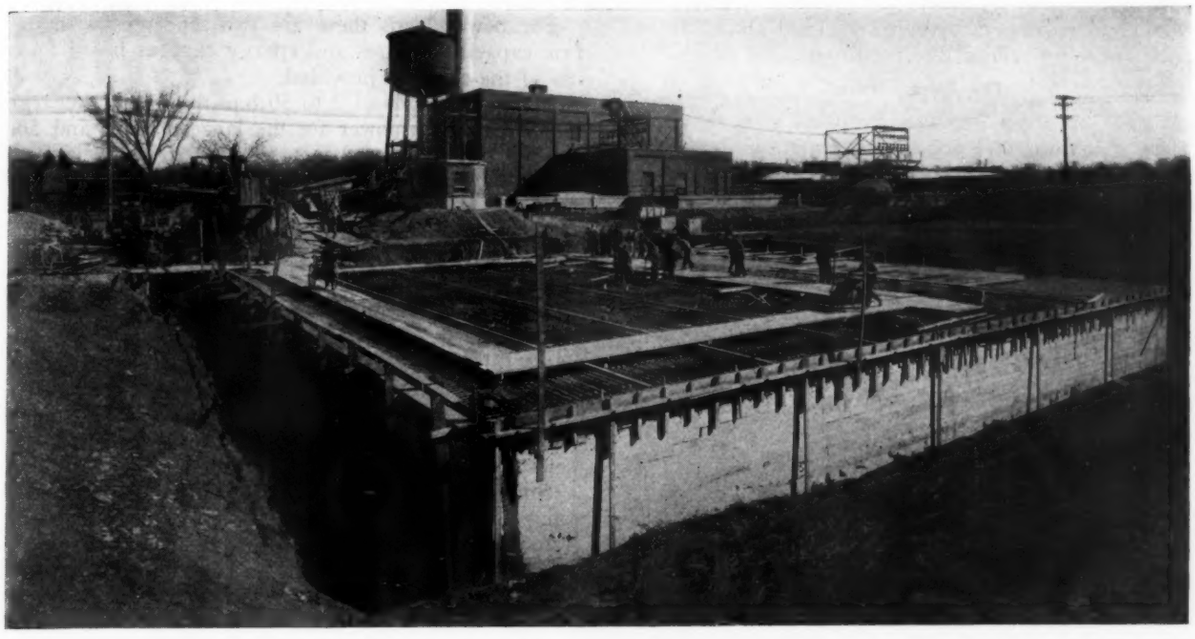
The City Engineer is preparing a Five-Year paving program totaling approximately 300,000 square yards, with a probable total length of 13 miles, construction to be somewhat evenly distributed over a five-year period.

The surveys, plans and specifications are being prepared by the City's Engineering Department. Much of the anticipated work consists of the repaving of streets, on which the present paving is from eighteen to thirty years old, and on which the maintenance is becoming excessive. Efforts are being concentrated on the routing of main highways through the city. Where it is practical to do so, streets will be widened to relieve congestion.

Paul Morton is City Manager of Lexington and J. White Guyn is City Engineer.

Water Light and Power

A Special Section in PUBLIC WORKS *magazine devoted to the interests of publicly owned utilities.*



Pouring top of reinforced concrete additional clear well; constructed as a work relief project.

A Town That Got Something for Nothing

By W. O. Myers

City Engineer and Superintendent, Ottawa, Kans., Water and Light Dept.

NOT often does a town get "something for nothing," but the citizens of Ottawa, Kans., apparently did, for they own a municipal water works and electric plant which has cost the taxpayers nothing and also has made a nice profit for the city.

Financial Brief

Ottawa, a town of 9,562 located in an agricultural section about 50 miles south-east of Kansas City, became dissatisfied with the services rendered by the privately owned water and light plant, and purchased it, taking possession July 1, 1906; issuing bonds for $150,000, which was disbursed as follows:

Purchase of water works	$ 60,000
Water works improvements	65,000
Purchase of electric plant	10,000
Electric plant improvements	15,000
	$150,000

Since then additional bonds have been issued as follows:

In 1919: For river storage dam	$ 23,600
" 1920: For boilers	20,000
" 1921: Water and electric extensions	165,000
" 1921: Filtration plant	93,000
	$301,600
Total bonds issued	$451,600

All payments of interest and retirement of bonds have been made from the earnings of the utility, and the bonded debt January 1, 1935, was $287,000.

The assets at that date were:

Cash on hand	$ 67,647.48
Reserve fund (bonds owned)	467,175.00
Sinking fund (bonds owned)	18,500.00
Excess of accounts receivable over accounts payable	11,664.79
Total current assets	$564,987.27
Leaving a net balance of	277,987.27

Meantime extensions and improvements made from earnings have increased the value of the property to $860,000.00

Giving total net assets of $1,137,987.27

as the profit to the city from 28½ years' operation.

The utility has paid no taxes, but it has transferred to the city's "general fund" earnings totaling $342,500,

which is probably in excess of taxes that would have been paid by the same plant under private ownership. In 1934, $90,000 was transferred, or more than 10% of the value of the property, or 44% of the year's revenue. The 1935 budget calls for a transfer of $80,000.

Meantime, the consumers have been charged rates lower than the general average charged elsewhere by plants operating under like conditions.

The Electric Plant

When purchased, the electric plant comprised one 75 kw generator and one 45 kw generator both belt-driven by steam engines. Only the 75 kw generator and its engine were retained in the new plant, and this was moved to a new location, safe from floods, and supplemented by a new 130 kw direct connected to a steam engine. To provide steam for these and for the water works pumps, three 66" x 18" fire-tube boilers were installed, and a fourth was added in 1914. In 1922 these were removed and replaced by three 323 h.p. Springfield water-tube boilers equipped with Foster superheaters; and a fourth similar boiler was added in 1930.

The electrical generating equipment now consists of three steam turbo units—a 2,500 kw and a 1,250 kw General Electric, and a 500 kw Westinghouse geared unit. An electrically operated G. E. switchboard was recently installed.

Coal, fuel oil and natural gas have been used for fuel. At the present time natural gas, supplied mostly from local wells, is used at a cost of 14c per thousand cubic feet and a stand-by service is maintained by the local gas distributing company, a subsidiary of the Cities Service Company. The local producers pay the cost in excess of 15c per thousand cubic feet for pipe line gas used. The pipe line gas has a slightly higher heat content than the local gas.

There were 163 consumers of electricity when the city bought the plant and the receipts for electric serice in 1907 were $6,985.09. In 1934 there were 3,336 local consumers and the receipts were $155,733.71, including $18,434.22 for 1,515,719 kilowatt-hours furnished to two transmission line customers—the City of Pomona and the Kansas City Power & Light Co., supplied at the switchboard.

Following 1915, four neighboring towns built transmission lines to take current at the switchboard; which lines, except Pomono's, are now owned by the K. C. Power & Light Co., and at present 19 towns are so supplied by the Ottawa plant, as well as a rock crushing plant. In 1934, 19.5% of the current generated was sold for transmission.

The service furnished for city purposes is paid for out of the proper funds, excepting some traded for use of quarters occupied by the Water and Light Department in the city hall and services rendered by other city departments for which there is no accounting. The city clerk's office is paid $600 per year for handling the payments made by the customers.

Power used to operate the sewage disposal plant is paid for at the same rates charged others for similar service. For 120 post lights with one 4,000 lumen 15 amp. lamp per post in the business district, the charge is 4c per kilowatt-hour, which includes maintenance. The cost per post averages near $2.40 per month. In the residence districts 327 1,000 lumen, 6.6 amp. lamps are furnished at $15.00 per year each.

For residence and commercial lighting a rate of 4c per k.w.h. is charged for the first 300 per month and 3c for the excess. The minimum is 75c per month and customers may use single phase motors up to a total of five horse-power (counting those 1 h.p. and larger) on the lighting meters, but the monthly minimum is increased 75c per h.p. Customers outside the city limits pay 6c per k.w.h. for the first fifty used and $1.00 minimum.

For power loads there are two schedules with flat rate capacity charges and energy charges based upon use of the capacity provided.

For power loads of 2 to 50 h.p. the flat rate charge is 75c per horse-power for the largest motor and 50c per h.p. for additional motors, and an energy charge 2c per k.w.h. for the first fifty k.w.h. per dollar of flat rate, 1½c per k.w.h. for the next fifty and 1c for all in excess of 100 k.w.h. per dollar of flat rate charge established. For larger power loads, the flat rate charged is based upon the maximum demand measured over a 30 minute interval and is $1.00 per kw for ten or less, and 75c per kw for maximum demand in excess of ten kilowatts; with an energy charge of 2c per k.w.h. for the first sixty hours use of demand, 1½c for the next sixty and 1c for all over 120 hours use. Customers with less than 50 h.p. connected may select this schedule.

Some large industrial power users under restrictions as to time power is used receive service as low as 1.2c per k.w.h.

Electric cooking service is supplied through separate meters at a flat rate of $1.50 per month plus an energy charge of 2c per k.w.h.; water heaters are supplied with no additional capacity charge if used when the cooking range is not in use.

In 1934, 7,846,680 k.w.h. was generated; and the average for the past six years has been 7,627,240 k.w.h. New motor-driven water works pumps used 302,540 k.w.h. in 1933 and 305,620 k.w.h. in 1934.

For the year 1934 the sources of revenue for electric service were as follows:

Commercial service	$ 38,151.09
Residence service	53,090.25
Transmission lines	17,995.05
Rated Power	8,193.24
Demand Power	10,187.29
Industrial Power	18,830.75
Street Lighting	8,393.36
Special service	80.68
*Connecting Fees	812.00
	$155,733.71

The Water Works Plant

Water is pumped from the river three-fourths of a mile to the new station, where it is purified and pumped to the distribution system. At the river station, centrifugal pumps set below low water level are driven by electric motors located above known high water level and controlled from the main station. At the main station are the purification plant, a 5,000,000-gallon reservoir, and two 2 mgd steam pumps.

The treatment consists of coagulation with iron sulphate and lime, sedimentation and filtration. Water enters a baffled mixing chamber where lime solution is applied and then passes through a mixing channel 150 feet long and into a chamber 12' x 20' with 13' depth of water, agitated slightly by the entering current of water. Iron sulphate is applied at the entrance of this mixing channel and the floc forms in the chamber. The coagulated water then passes through a baffled concrete sedimentation basin allowing four to six hours time for clarification, and the effluent flows by gravity

*A fee of $1.00 is charged for installing meters.

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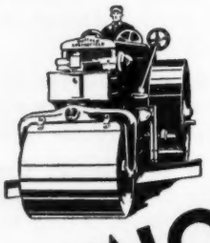

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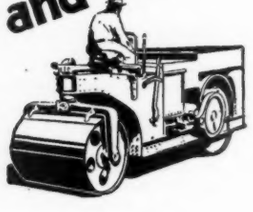

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into the storage reservoir, which is used as a spray pond for the electric plant with the result that the clarified and partially softened water is well aerated.

The reservoir water flows by gravity through a float-controlled valve into a coagulating basin, being treated with alum, ammonium sulphate and chlorine as it passes through a baffled mixing section in one corner of this basin. Activated carbon is applied at the outlet and mixes with the water in its travel through the influent pipe to the filters. Sufficient chlorine is applied at the entrance of the coagulating basin to give the desired residual in the water leaving the plant. There are three gravity filter units, each of 750,000 gpd capacity, equipped with operating tables, hydraulic valves and rate controllers. Wash water is accumulated in a tank on a steel tower and applied through a rate controller.

The filters and a 1,000 g.p.m. Worthington crank and fly-wheel Corliss type pump are housed in a one-story brick addition opening into the engine room containing other pumps and the electric generating equipment. The two steam pumps first installed by the city have been lowered into a basement and will be made available for emergency use. Motor-driven centrifugal pumps—one 1,000 g.p.m. and one 1,500 g.p.m. capacity—are now used for pumping to the distributing system.

The commercial rates are: first 400 cu. ft. per month at 25c per hundred (minimum 50c); next 3,000 cu. ft. @ 15c; next 6,600 cu. ft. @ 12½c; in excess of 10,000 cu. ft. @ 6½c per hundred cubic feet.

Water service for private homes in excess of 400 cubic feet per month is sold at a rate (10c per hundred cu. ft.) lower than the established schedule, it being assumed that the larger quantities will be used for watering trees, shrubs and lawns and thereby benefit the community.

The Santa Fe Railway Co. uses more than 30% of the water pumped and on account of providing electrically controlled valves, permitting the operator at the water works to shut off two large sources of supply to water tanks during times when excessive quantities may be needed for fighting fires, is given a 4½c rate for all in excess of 100,000 cu. ft. per month. The average rate for 100,446,414 gallons used in 1934 was 6.34c per gal.

For the public fire service, annual rates of $42.50, $40.00 and $15.00 each are charged for fire-hydrants, the price depending upon location and time installed, the average being about $36.00 each. The 1934 cost was $7,685. No extra charge is made for water drawn from fire-hydrants for flushing sewers or supplying the street sweeper and power tree sprayer.

The total of water pumped in 1934 was 306,743,900 gal. and total receipts, including public fire service, were $49,927.39.

Since 1913 Ottawa has had the commission form of government. E. V. Gibson, Mayor; H. E. Rodgers, Commissioner of Finance and Revenue, and H. W. Johnson, Commissioner of Streets and Public Utilities, are the present members of the governing body. The commissioner of streets and public utilities is in direct charge of the municipal utilities. At the time the property was purchased and up to the adoption of the commision plan in 1913, the plant was under the control of a non-partisan board of three commissioners appointed by the mayor and council. H. W. Johnson is now serving his fourth consecutive term as Commissioner of Utilities, first being elected to the office in 1925.

3-Furrow Gang Plow-Tractor Unit

Sand Bituminous Road Mix Construction

By H. C. Weathers
Directing Engineer of Tests, State Road Department of Florida

THIS type of surface is a mixture of existing road material and bitumen, in which all mixing is done mechanically on the road. Requisites include: a dry, warm climate; medium traffic; sandy soils; and good drainage. Most of the work has been done in sections where traffic is light, but it is believed this type of surface will carry up to 1,500 vehicles per day. Good drainage is highly important.

Securing Preliminary Data

Representative samples of existing road materials are taken from the surface to a depth of 8 or 10 inches, at intervals of about 500 feet, or wherever there are material changes in quality or gradation. These samples are tested for silica, clay, loam, silt and foreign matter; sieve analyses are made and stability or bearing values determined.

A well-graded, coarse sand is preferable. The finer the size of the sand particles, the more bituminous material will be required. Some of the sands have contained very little 10 or 80-mesh material, being 80% to 90% 40-mesh material. No effort has been made to correct gradings, and very few ill effects have resulted from the use of such materials especially when the particles are angular. As a rule, loam and silt do not affect the quality; in fact, they aid in stability. Clay in excess of about 10% causes balling, and material containing it is considered unfit for use.

The test which has proven of greatest value is that for stability, since lack of this factor resulted in slowly moving or stationary loads sinking into the pavement surface. A machine patterned after the one developed by the Bureau of Public Roads has been used with very good results. A stability of 25 pounds or more gives uniformly good results, and has been adopted as the minimum. It was found that the project on which difficulty was encountered had a stability of only 6. When it is found necessary or desirable to recondition the existing materials before construction, the laboratory makes the tests and determines the proper admixtures of materials for a satisfactory degree of stability.

Bituminous Materials

Cut-back asphalt and refined coal tar are considered standard for this construction. The penetration of the base asphalt before cutting back with naphtha ordinarily should be between 85 and 100; but when there is a considerable percentage of silt, loam and some clay, a penetration of 100 to 120 is better; and where the aggregate lacks stability, a 50-60 base penetration asphalt has been used.

The coal tar base should be composed of 85% to 97% by volume of refined coal tar and 15% to 3% pitch oil as directed. The ratio of pitch oil to tar may vary according to the type of soil, acid soils generally taking a higher percentage of pitch oil. The mixture should be composed of 80 to 93% base and 20 to 7% flux.

The amount of bituminous material varies with the nature and grading of the aggregate, as well as with its surface texture. Finer materials, or rough-textured materials require more bitumen. The determination of the amount required is made by means of a combination laboratory investigation and trial in the field. Samples of the sand are analyzed in the laboratory, and small batches of mixtures made up. From the results of these studies, the field engineer is furnished with the approximate quantity of bituminous materials needed. He then uses his own judgment after trying a section with the predetermined quantity. The final mixture, after the last application of bitumen has been made and thoroughly mixed in, should have a black, glossy appearance. A mix with a brownish color is too lean and should be reworked, with the addition of more bituminous material.

Amount of Bitumen

On the work in Florida, from 3.5 to 7 gallons of bituminous material per square yard of 5-inch pavement has been used. Following is a table showing some typical sand gradings on active projects, along with the amounts of asphalt necessary to produce satisfactory results.

Sand gradings as determined by analyses					*Gallons of Oil per sq. yd. mix approx. 6" thick*
Sample No.	*Pass. 10 Ret. 40*	*Pass. 40 Ret. 80*	*Pass. 80 Ret. 200*	*Pass. 200*	
1	54.9	41.0	3.6	0.5	3.20
2	38.0	54.6	4.2	3.2	3.85
3	29.2	65.4	3.4	2.0	4.00
4	28.6	66.4	2.8	2.2	4.00
5	28.6	68.2	1.4	1.8	4.20
6	20.8	74.6	2.4	2.2	4.70
7	33.0	60.8	3.8	2.4	5.00
8	25.0	70.2	3.0	2.0	5.50

Note as the material changes from coarse to fine, the quantity of oil must be increased, which is in line with the theory of finer graded aggre-

gates having more surface area. However, sometimes this theory is upset as the quality and shape of the individual particle of the material plays an important part as is illustrated by Sample 7. This is a slightly coarser material in that it contains more 10 and less 40 than samples 4, 5 and 6, with the 80 and 200 mesh material being about the same, yet 7 requires a little more oil.

Constructing the Pavement

In preparing the existing road material, the grade is plowed to a depth 2 inches below the proposed depth of the pavement, and 6 inches from each proposed edge. Roots and foreign material are removed so far as practical, and the surface brought to the line and grade shown on the plans. Work should begin at the end of the highway so that no material will be hauled over the finished pavement. All automotive equipment is preferably equipped with balloon type tires, since these work much better in the sand.

A section about 3,000 feet long is worked at a time. The bituminous material is placed in successive applications of about 0.35 gallon per square yard, until the amount required to finish the mix is about 0.5 gal. Then the applications are reduced to 0.15 to 0.20 gal. to prevent flooding the mix.

After four applications of bitumen totalling about 1.5 gallons, the surface is well mixed with disc harrows to a depth of 3 to 4 inches, or about one-half the depth of the finished pavement. This 3 or 4 inches of mixed material is then pushed to the side in windrows with blade graders, and the same procedure of applying asphalt or tar, and mixing is followed with the base until a lean brown mix is obtained. This is then shaped with the blade, and the cover material pulled back over it, in three operations or layers. Each of these layers receives an application of 0.35 gal. bituminous material. After all the material in the windrow is back on the road, the edges and quarters are plowed to the full depth of the required pavement thickness, and the material is pulled over onto the road surface from 6 inches outside the specified width, using a 12-ft blade cutting to within ½ inch of the specified depth of the pavement at the edge.

After this operation, the final applications of bituminous materials are made with 0.15 to 0.20 gal per sq. yd. applications, and at the same time mixing operations are carried on with harrows and the 12-ft. blade. When using tar, the blade is used to obtain a uniform mix and the harrows to cut in each application. The 12-ft. blade has been very useful and advantageous on this work.

The mixed material is then rolled back to the edges, which method insures proper depth and uniform mix at these points. The thickness at the edges should be about 2 inches greater than at the center. During the final mix, a retread mixer and 12-ft. blades are used to insure a uniform and homogeneous mix.

The final finish of the surface is obtained with graders having 12-ft. blades, long wheelbase and light construction, preferably with a maximum weight of 8,000 pounds. Tires should be 12 to 14 inches in width, and should be equipped with scrapers. While the mix is new and soft, it is shaped to crown and grade. For the final finish, the blade is turned to its maximum angle with the pavement; the top of the moldboard is leaned forward so that the blade is at the maximum skinning or scraping position. In this way, the loose material is skinned down to a firm and solid mix. This is essential to prevent scabs from forming.

After the finishing, the pavement is rolled with a 5-ton tandem roller, preferably in the early morning before the pavement becomes warm or on cloudy days. Rolling is continued until the surface is free from roller marks. The surface is then checked for smoothness with a straightedge, and irregularities greater than ½ inch in 10 feet are shaved off. The edges of the pavement are cut with axes and shovels to a straight line and the resulting waste stock-piled for future use in constructing turnouts, parking places, etc.

By means of holes, trenches or coring tools, the depth of the finished pavement can be tested.

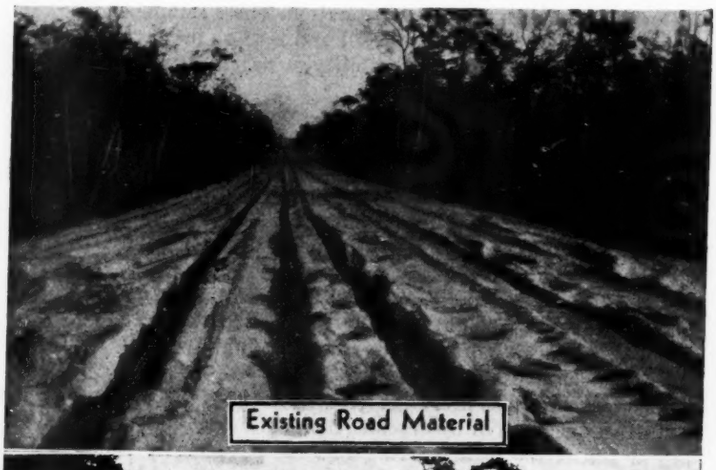
Personnel, Cost, Maintenance

The personnel required to construct this type of pavement should consist of 1 engineer, 1 superintendent and a crew of about 30 men, including tractor operators, mechanics, roller men and laborers.

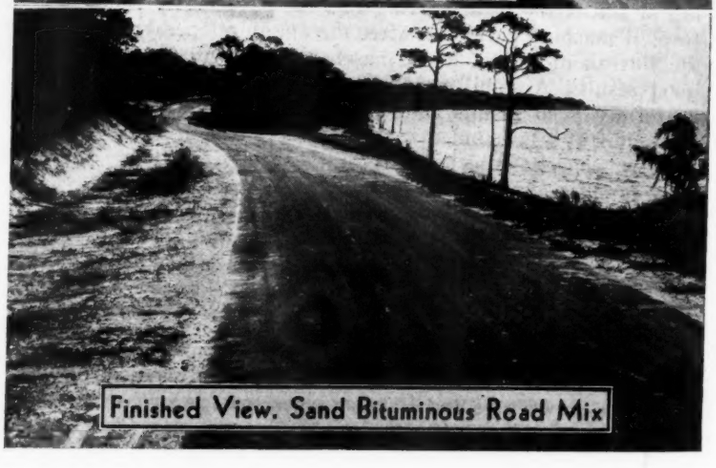
The State Road Department of Florida has constructed 287 miles of this road type, some of which is four years old. Approximately 255 miles have been built by force account with state forces, at an average cost of 41 cents a square yard. This cost covers actual construction of the pavement, including all materials, but it does not cover costs of preliminary grading.

To date there has been very little maintenance. The average maintenance cost has been about $180 per mile per year, which consists mostly of shoulder maintenance.

The construction details of the work have been supplied by F. E. Mitchell, project engineer, and the photographs are by E. K. Fogg, directing engineer, and G. L. Smith of the Bureau of Public Roads.



Existing Road Material



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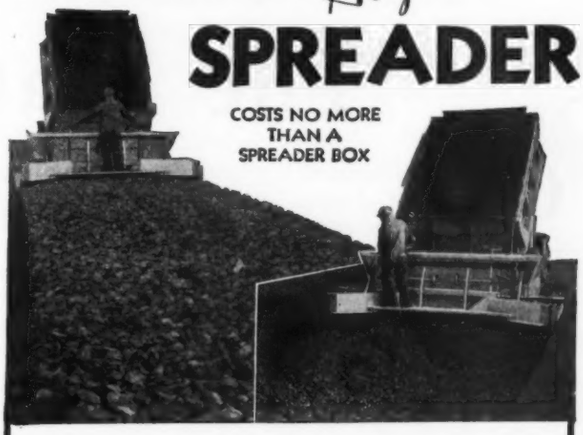

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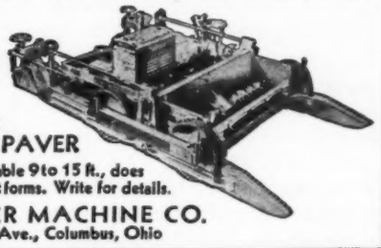

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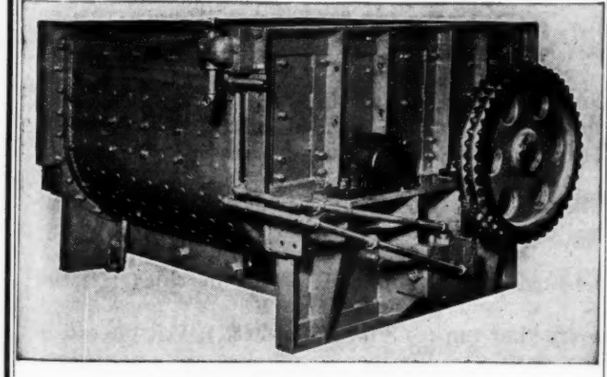

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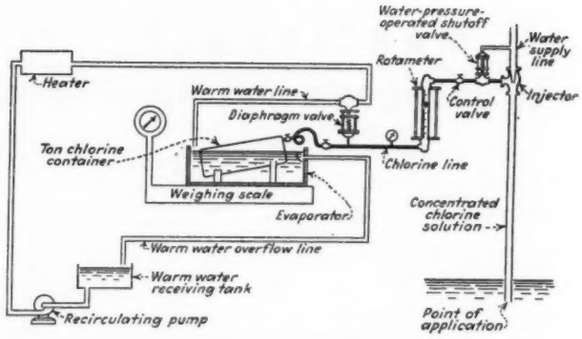
Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

The Water Wheel

CHLORINE control equipment for handling large amounts of chlorine in a limited space on Chicago's Dunne intake crib was designed especially for this service. The fundamental principle is maintaining a constantly uniform pressure in the 1-ton chlorine container by raising the temperature as the pressure falls. The container is placed in a steel evaporation tank through which warm water is circulated at a rate controlled by a diaphragm-operated valve, which in turn is controlled by the pressure of the chlorine discharged from the container. By passing the chlorine gas at a fixed pressure through a variable orifice a control of the flow is possible. The rate of chlorine flow is indicated by a rotometer, which consists of a vertical, tapered glass tube through which the gas passes upward, causing a revolving float or "rotor" to assume a position in the tube depending on the velocity of the gas through it, this position being read from a calibrated scale. The gas then flows to an injector where it is mixed with water and discharged into the intake shaft. Each tank is mounted on a 10-ton dial-type platform scale which automatically records the weight, time and date on a strip tape at 15 min. intervals.[E6-14]



Schematic diagram of the high-capacity chlorine-feeding equipment, Chicago. Automatic control of recirculating warm water maintains constant pressure in the chlorine container.

In chloramine treatment, "ammonia is utilized by the genus Nitrosomonas as a source of growth energy, and their excessive growth resultant from adding ammonia to a water supply is accompanied invariably by the formation of nitrites with its consequent high chlorine demand and interference with the orthotolidine test." Studies at Detroit led to the conclusion that: "(a) Great Lakes water (and presumably all surface waters) definitely contain nitrifying bacteria, of an undetermined species. (b) Artificial methods of culture are simple and direct. (c) Sand filtration after ammoniation promotes their growth during suitable water temperatures to a point where the chloramine process defeats its own purpose and becomes costly due to wasting of both ammonia to feed the bacteria and chlorine to oxidize their products. (d) Their resistance makes it appear impossible or impractical to control nitrification by chlorination."[A6-3]

Chloramine in reservoirs is superior to chlorine for controlling algae growths, but where detention after treatment exceeds 40 hrs. a second application may be necessary where water temperature is 70° F. or above. Certain types of algae develop a resistance or tolerance to chlorine, in which state they are especially responsive to copper sulphate treatment. Chlorine sufficient in amount to partially oxidize organic matter may result in the putrefaction of sludge in reservoirs; as may also copper sulphate, either alone or following the application of chlorine.[A6-6]

Powdered activated carbon may be used successfully in non-filtration plants for removing taste and odor-producing substances, provided the water is properly coagulated and settled after the application of the carbon. It may, when used in conjunction with chloramine, stabilize sludge in reservoirs. Also it may prevent algae growths when a sufficient quantity is present to shut off light from reservoir walls.[A6-6]

The most recent development in its use is in Norfolk, Va., and Easton, Pa., where 0.5 ppm is applied to filter wash water. Apparently it causes filters to run longer and remove more taste-producing organisms.[A6-11]

Aeration of the surface supply of Ossining, N. Y., as it enters the raw water settling basin and again between the filters and clear-water basin has been the practice with the plant put in operation in April, 1931. At first a pre-chlorine dose was applied before the pre-aeration, but since the fall of 1933 the chlorine was added after aeration, and equally satisfactory odor removal obtained at half the cost. With activated carbon at 6 cts, chlorine at 5½ cts and ammonium sulphate at 7 cts, the costs of the three chemicals named, per million gallons, were \$1.50 + \$0.60 + \$0.19 = \$2.29 without pre-aeration, and \$0.90 + \$0.38 + \$0.19 = \$1.47 with pre-aeration; from each of which is deducted \$0.64 for the saving in alum due to the use of the carbon, leaving the cost of color removal \$1.65 and \$0.83 respectively. The latter is 2 cts per capita per year.[A6-10]

Efficiency of filtration, defined as "ratio of the actual plant output to the nominal capacity," can be represented by the formula $H = \frac{K}{V^n}$, in which H is the hours filter run (to 8 pt. loss of head), V is the rate of filtration in gallons per square foot per minute, and K is a constant dependent on the treatment applied; based on studies by H. E. Hudson, Jr., at the Chicago experimental filtration plant. For Chicago, $n = 1.5$ fits quite well. The data "show as consistent a relationship between filter runs and filtration rate as between clogging rate and filtration rate. Hence it is concluded that for any one plant the length of filter runs is as good a criterion of filter performance as the clogging rate." The relationship is for a constant settling time, which generally varies inversely as the rate of filtration; such change would probably involve a change in the exponent n in the formula.[E5-4]

Pumping costs were decreased from $50 per mg. to $30, giving a monthly saving of $115 to $125 by installing a new pumping unit at a cost of $680 in Rockingham, N. C. Removal of a large consumer reduced consumption almost 50%; the 750 gpm centrifugal pump with 75 hp. induction motor was run only 5 hrs. a day; but due to fixed demand charge, the power bill was reduced only 25%. By substituting a 30 hp. GE squirrel-cage induction motor and a 300 gpm Ingersoll-Rand centrifugal pump, the demand charge was cut from $120 for 80 hp. to $52.50 for 37 hp. Further saving was obtained by improved efficiencies, by installation of automatic control equipment, lower main friction, etc.[A6-5]

A prestressed concrete water tank with vertical joints was recently built at Waukesha, Wis.; inside diameter 50 ft., height 46 ft.; 675,750 gal. capacity; cost $17,264. Wall 10 in. thick throughout, built in 8 sections, reinforced vertically in both faces, and horizontally by rods tightened by turnbuckles; outside of which is a 4 in. protective shell of concrete, built in 12 vertical sections, and sand-blasted for architectural effect. Two coats of asphalt emulsion were applied under pressure to the inside, with a third coat of asphalt and sand. Tank was filled and tested for leaks before outside wall was placed; not even a moist spot shows to date.[E5-3]

Services in Kirkland Lake (Canada) are laid in pairs, two in one trench, which cost very little more than one pipe with a "Y" branch to serve two houses, which latter had proved unsatisfactory. In electrical thawing, this gave a perfect electrical connection between the two houses. So far as possible, a house service is tapped into every hydrant lead, which maintains circulation in the lead.[M5-6]

Bibliography of Recent Water Works Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

A *Journal, American Water Works Association*

6 *April*

1. *t.* Pressure Head in Perforated Pipes. By N. Malishevsky, pp. 413-418.
2. Underground Corrosion in the Southeastern United States. By K. H. Logan, pp. 419-438.
3. Nitrifying Bacteria in Water Supplies. Douglas Feben, pp. 439-447.
4. Elizabeth City's Struggle for an Acceptable Water Supply. By J. C. Parker, pp. 448-453.
5. Operating Economies Effected Through Installation of Smaller Pumping Equipment. By E. R. Tull, pp. 454-457.
6. Taste and Odor Control at Council Bluffs. By Wm. T. Bailey, pp. 458-471.
7. Relief Program in Buffalo. By F. J. Downing, pp. 472-478.
8. Ground Water Problems of the Coastal Plain. By O. E. Meinzer, pp. 479-484.
9. Water Waste Surveys and Distribution Systems Studies. By D. D. Gross, pp. 485-493.
10. Color and Odor Removal at Ossining, N. Y. By W. T. Miller and J. E. Kerslake, pp. 494-502.
11. The Trend of Modern Taste and Odor Control. By F. E. Stuart, pp. 503-508.
12. Stream Gaging Activities in North Carolina During the Past Year. By E. D. Burchard, pp. 509-512.
13. Menace of Soil Erosion. By J. H. Stallings, pp. 513-519.
14. Proposed Gravity Water System for Wenatchee Valley, Washington. By F. J. Sharkey, pp. 520-529.

D *The Surveyor*

6 *April 19*

1. Water Purification at Perth: Chloramine Treatment. By Cyril Walmesley, pp. 517-518.

May 10

2. Rainfall in Relation to Discharges from Medium-Sized Catchment Areas. By L. R. B. Green, pp. 589-590.

E *Engineering News-Record*

6 *April 18*

1. Reactions at Pipe Bends in Water Distribution Systems. By I. Goldfien, p. 566.

May 2

2. The Ohio River as a Water Supply Source. By H. W. Streeter, pp. 612-615.
3. Water Consumption Rises; Many Supplies Require Expansion. By N. S. Hill, Jr., pp. 616-618.

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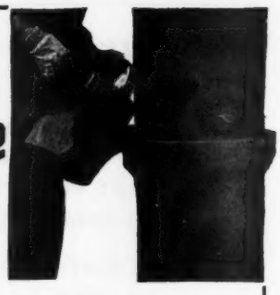

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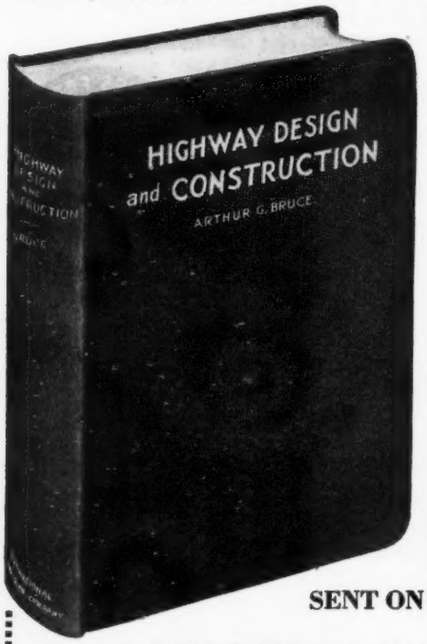

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4. Emergency Measures Defer Approaching Water Shortage. By Meloy Smith, pp. 618-620.
5. Ohio Valley Well Supplies Subject to Slow Reduction of Capacity. By O. E. Meinzer, pp. 621-622.
6. Tanks and Booster Stations Demonstrate Their Value. By D. H. Maxwell, pp. 623-624.
7. Elevated Tanks in Detroit Eliminate Pressure Pulsations. By G. H. Fenkel, p. 624.
8. Storage on Distribution System Raises Pressures and Reduces Pumping. By J. P. Schwada, pp. 625-626.
9. Indianapolis Pressure Improved and Pumping Costs Reduced. By W. C. Mabel, pp. 626-627.
10. Kansas City, Kan., Installs 5 Tanks and Booster Districts. By J. D. Donovan, p. 628.
11. New Equipment and Materials Aid Water Engineer's Task. By T. H. Wiggin, pp. 629-632.
12. Flexibility in Design Aids Purification Plant Operation. By Paul Hansen, pp. 633-636.
13. Odor-Control Methods Aided by New Test Technique. By M. W. Cowles, pp. 636-637.
14. Largest Ammonia-Chlorine Plant Installed on Lake Crib. By A. E. Gorman, A. H. Gerstein and P. H. Peterman, pp. 638-640.
15. Meters and Meter Records Present Economy Opportunities. By A. S. Hibbs, pp. 641-642.
16. True Economy Demands Weighing Improvements Against Possible Gain. By T. A. Leisen, p. 642.
17. Water Purity Endangered by Diversion of Water Funds. By G. N. Schoonmaker, p. 643.
18. Water Funds Widely Used to Supplement Tax Revenues. By N. T. Veatch, Jr., p. 644.
19. Water Works Operation a Problem Dependent on Personnel. By H. E. Jordan, p. 645.

May 16

20. Nation's Water Problems Discussed at AWWA Convention, pp. 713-716.

F 6 — *Water Works Engineering*

April 17

1. Hamilton (Ont.) Plant Meets Variable Conditions in Treating Lake Water. By W. L. McFaul, pp. 375-378.
2. Regulations for Meter Accuracy. By N. N. Wolpert, pp. 379-381, 407.

May 1

3. Modern Filter Plant Control. By H. E. Jordan, pp. 452-453, 512.
4. Plan to Remodel Cincinnati Purification Plant. By C. S. Timanus, pp. 454-456.
5. Experience with Slow Sand Filtration. By C. M. Saville, pp. 457-461.
6. Service Piping Friction Losses. By J. E. Gibson, pp. 467-468, 471.
7. Why Pipe Thawing Starts Fires. By Fred Shepperd, pp. 472, 475.
8. St. Louis Installs 13-Mile Conduit. By C. M. Daly, pp. 476, 479-480.
9. Detection of Flaws in Protective Coatings. By G. W. Clarvoe, pp. 483-484, 487.

G 6 — *Water Works and Sewerage*

April

1. Hydraulics of Rapid Sand Filters. By G. G. Dixon, pp. 103-107.
2. Reminiscing on the Installation of Mechanical Filtration. By I. H. Jewell, pp. 112-114.
3. Hydrant Discharge Measurements and Application to Problems of Water Works Operator. By P. S. Wilson, pp. 115-119.
4. Million Gallon Storage Tank at Dallas. By J. B. Winder, pp. 133-134.

J 6 — *American City*

May

1. The Logic of Universal Metering. By M. P. Davidson, pp. 63-64.
2. Automatic Softening Plant for Utica's Water Supply, pp. 65-66.
3. Preserving the Artesian Water Supply of Honolulu, p. 71.
4. Iron and Manganese Removal at Lincoln, Neb. By D. L. Erickson, pp. 75-76.

M 6 — *The Canadian Engineer*

April 30

1. New Deep-Well Water Supply for Fergus, Ont. By D. H. Fleming, pp. 5-7.
2. Mechanical Control in the Operation of Water Works. By A. H. R. Thomas, pp. 13-14.
3. Water Works Financing and Accounting. By G. P. Gordon, pp. 15-16.

May 1

4. Chlorine and Chloramines in Water Treatment. By A. E. Griffin, pp. 17-18.

N 6 — *Earth Mover*

May

1. *c.* Colorado Aqueduct Construction Camps, pp. 11-14.

P 6 — *Public Works*

May

1. Water Works and Sewage Progress in the Central States, pp. 9-10.
2. Pressure Zeolite Softening at Elmore, O. By R. F. MacDowell, pp. 10, 13.
3. Lime-Soda Water Softening at Grafton, O. By R. F. MacDowell, pp. 11-12.
4. Operating Results at the Burnt Mills Purification Plant. By Robert B. Morse, pp. 20-22.
5. Thirteen Miles of Large Steel Mains Laid by St. Louis. By C. M. Daily, pp. 25-26.
6. Soil Technology in Earth Dam Construction. By C. A. Hogentogler, pp. 28, 30.
7. Horton, Kans., Municipal Light and Power Plant. By H. L. Lingo, p. 31.
8. Constructing a 10-Mile Pipe Line with Relief Labor, pp. 33-34.

T 6 — *La Technique Sanitaire*

March

1. Stabilisation des Eaux Ferrugineuses. By M. A. Guillerd, pp. 58-60.

U 6 — *Public Works Engineers Year Book*

Year 1935

1. Trends in Water Works Practice. By Paul Hansen, pp. 119-123.

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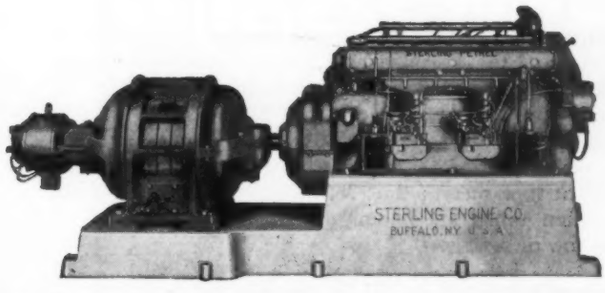

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A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

CHLORINATING activated sludge was studied at the New Jersey State laboratory, and it was found that supernatant liquors from mixtures of activated sludge and sewage increased in turbidity and B. O. D. after chlorination and still further after aeration. The sludge volume increased after chlorination but decreased after 6 hours aeration of the chlorinated material. Chlorination of mixed liquor may either increase or decrease the B. O. D. of the mixture. Chlorination of activated sludge proper reduced its B. O. D., the amount of reduction depending upon the character of the sludge and degree of oxidation.

General conclusions drawn were: (1) Activated sludge requires a balanced flora and fauna for maximum degree of purification and stabilization. (2) Complete chlorination (sufficient to produce a trace or more of residual chlorine in the treated material) of activated sludge mixtures is a dangerous tool in control and affects clarification as well as oxidation or stabilization. (3) The B. O. D. of activated sludge, alone, may be materially decreased by chlorination. (4) Turbidity and B. O. D. of supernatant liquor or effluents may increase considerably as the result of complete chlorination of mixtures of activated sludge and sewage, whether the chlorine be added before or after 6 hours of aeration.[G6-1]

Secondary settling tanks at Kenneth Square, Penn., have outlet weirs of unusual design. In each weir is a row of 1" holes 15" on centers drilled 4" below the crest. "This arrangement tends to equalize the discharge from the siphon chamber and sprinkling filter and to permit a more uniform discharge of the final plant effluent. During the minimum flow period the sewage is discharged through the holes, while at the maximum rate of flow the level of the sewage rises and a portion of the liquid flows over the crest of the weir."[H5-1]

Automatic control of return sludge is an unusual feature of the Bernardsville, N. J., activated sludge plant. Sludge from the first sedimentation tank is returned by small twin ejectors, automatically timed to fill and discharge (at intervals of two minutes or less) by connection of the air discharge regulator with an effluent flow meter; thus returning to the inlet of the aeration tanks an amount of sludge proportional to the flow of sewage.[G6-4]

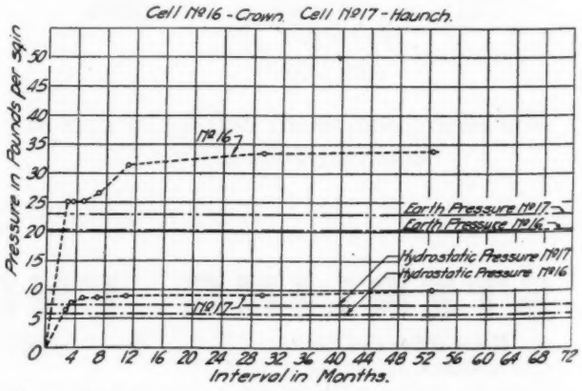
Power required for all purposes in the Bernardsville plant treating an average flow of 91,000 gpd. averaged 119 kwh. per day; the plant minimum including straight-line cleaning mechanism of pre-settling tanks; 3 air blowers delivering 2.58 cu. ft. per gal. against 3.75 lbs. pressure; final settling tanks with spiral sludge scrapers; plunger-type sludge pumps; and sludge ejectors for return sludge.[G6-4]

Sprinkling filter dosing should be frequent with small doses, studies of 16 New Jersey plants indicate. For a period during the peak rate of application of a dose, the filter discharge differed little from the applied sewage, while the early and late effluent from each dosing was highly purified; this being most noticeable in filters of 6 ft. depth or less, on those having large stone as a filter medium, and those with poor distributioin. Mr. Forman believes best results are obtainable with small siphon tanks or other arrangements for producing almost continuous short cycles of application and rest (displacement floats could be placed in existing tanks), and use of smaller media and possibly shallow tanks.[G6-4]

Activated carbon (powdered) assists sludge digestion in tanks where overloading exists or seeding was insufficient (ratio of green sludge to digested sludge too high). Adding 6.6 gms. of carbon per liter of sludge reduced time of peak gas production from 127 days to 70 and twice this dose to 42 days. Also drainability on filters or beds had been increased 47 to 70%. Added to settled or crude sewage (35 lbs. per mg.) no reduction in oxygen demand was noted but scum production on the surface of the settling tank was markedly less. Adding to a foaming tank might increase foaming temporarly, but the tank performance would be better in the end—the supernatant would be cleaner.[G6-4]

Earth pressures on sewers in deep tunnels were measured at intervals during five or six years after construction by Professors Young and Dunbar, University of Toronto, using fifteen Goldbeck pressure cells, which were placed at both crown and haunch during construction, the diaphragm of each cell being placed against undisturbed soil. The sewers were built in Toronto, mostly in tunnel under air pressure, depths reaching a maximum of 92 ft. After backfilling between sewer and tunnel, voids were grouted under 80 lb. pressure. The soil varied from dry sand to very wet sandy gravel and blue clay.

Eight of the fifteen cells gave pressures ranging from 26.9 to 61.8% of those due to the full weight of the earth above the cell at 110 lb. per cu.ft. Three gave no perceptible reading and three others gave pressures equal to or greater than full earth pressure. (Possibly cement or water in the cell may account for these—but



Observed (broken lines) and calculated (straight line) pressures at Chaplin station.

possibly not.) Variations in soil conditions adjacent to the cells more than offset any consistent relation between pressure at crown and at haunch. No definite relation was found between developed pressure and water content or screen analysis of soil, except that for a very dry soil the pressures were very small, even after a lapse of five years.[M6-2]

Non-corrodable pipe metal under any and all conditions probably will never be available. Corrosion of the interior of the pipe can be prevented by treating the water. That of interior and exterior, by coating the pipe. Coatings recommended are portland cement and bituminous enamels. For cementing large pipes in place machine has been developed that throws the mortar by centrifugal action onto the wall of the pipe and rotating trowels immediately smooth it. Cementing 4″ to 6″ pipe has been done in Australia by the Tate process, in which the pipes are first cleaned by a rotary blade cleaner, then cement mortar is inserted, followed by a mandril moving at a rate of about 20′ a minute, which packs the mortar smoothly against the pipe. In applying bitumastic enamel to pipes in place 30″ or more in diameter, the surface is scraped and wire brushed and priming applied at once before moisture condenses on the surface. Ventilation is necessary for the workmen, and possibly air conditioning to prevent moisture condensation. Air tools are preferable to electric motors, which heat the air while the former helps to ventilate.[E6-20]

Measuring flow of sewage in sewers or treatment works is best accomplished by use of automatic recording gauges. Two types are used—pressure type and float-operated type. The Bristol and Foxboro are examples of the former; the Gurley, Friez, Stevens and Lietz of the latter type. In general, the pressure type costs less and is cheaper to install; the float type uses a rectangular chart, is more accurate, and retains its setting for a longer period. These may be used for determining hydraulic gradients between gauges, or the depth of flow over weirs. The gauge should be located above ground so that its housing can be ventilated and kept dry and free from sewage gases. For clocks, the electric synchronous is recommended—they exert more power than others and generate enough heat to keep the paper dry.

Where the flow is in channels, the Venturi flume or Parshall flume may be used.[H6-3]

Centralized treatment of Greater London sewage is recommended by the Ministry of Health, to embrace an area of 25 miles radius from Charing Cross, 1,928 sq. mi., 13,000,000 present population, 15,000,000 in 40 yrs. The sewage of the "County Council" area is combined, but in the outside area only 10% is on the combined system. Three times the dry-weather flow, assumed at 110 gpd. per capita, is to be treated. At present this area contains 182 disposal plants of importance serving 140 local authorities.

Three general plans are suggested: That recommended would serve the entire area with 10 plants; another with 23 plants; and by the third all sewage would be intercepted by a main sewer and discharged into the sea at Dungeness. The first would cost $250,000,000; the last $550,000,000. The cost of running and maintaining the 10 plants is estimated at 50 cts. per capita per year.

Present plants vary from broad irrigation to complete treatment with activated sludge; the commonest

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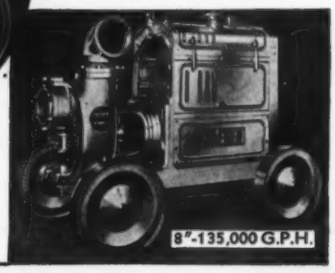

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being sedimentation, percolating filters and humus tanks. Many plants, originally in open country, have "become embedded in urban areas," with no room for needed expansion and therefore increasing nuisance and stream pollution.[D5-6.]

Fuel value of sludge bears a more or less definite relation to its volatile-matter content, which is readily and quite commonly determined. From available data, Fair and Moore derived the formula $Q=85\ P^{1.085}-700$ for plain sedimentation sludge, and $Q=69.2\ P^{1.085}$ for activated sludge; in which Q is the fuel value in Btu per pound of dry solids and P is percent volatile water in dry solids. For sludge containing chemicals, some correction is necessary, otherwise the fuel value as calculated will be somewhat too low. A fresh sludge consisting entirely of volatile matter would have a fuel value of about 12,000 Btu. Digested sludges seldom appear to have fuel values greater than 6,500 and may fall as low as 2,000 when heavily digested. Undigested activated sludge apparently has a fuel value of 6,000 to 7,500 Btu., and 4,000 to 6,000 after digestion.[E6-2]

Bibliography of Recent Sewerage Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

D — *The Surveyor*
6 — *April 12*
1. Experiments in Treating Trade Wastes at Shipley, pp. 475-476.
2. Albuminoid Ammonia Determination. (Discussion of D5-7), pp. 477-478.
3. Ilford and Barking Joint Sewerage, pp. 489-490.

April 19
4. Sludge Digestion and Distillery Waste Treatment at Stockport. By A. R. Ward, pp. 515-516.

May 10
5. Mechanized Chemical Treatment Plant for Sewage Purification (Birmingham, Ala.), pp. 591-592.

May 17
6. Activated Sludge Treatment at Manchester, pp. 615-618.
7. Sewage Sludge as a Marketable Fertilizer, pp. 623-624.

E — *Engineering News-Record*
6 — *April 18*
1. Sewer Reconstruction Problems in Subway Building. By S. D. Bleich and A. Brahdy, pp. 552-556.

May 9
2. Sewage Sludge Fuel Value Related to Volatile Matter. By Gordon M. Fair and Edward W. Moore, pp. 681-683.

May 23
3. Sewage Treatment Processes Aided by Long Outfall. By H. W. Taylor, pp. 739-741.

G — *Water Works and Sewerage*
6 — *April*
1. Effect of Chlorination on Activated Sludge. By Willem Rudolfs and N. S. Chamberlin, pp. 109-111.
2. Evaluation of Chemical and Other Methods of Sewage Treatment. By A. Potter and E. T. Killam, pp. 129-132.
3. The Treatment of Beer Slop and Similar Wastes. By A. M. Buswell, pp. 135-138.
4. Meeting of N. J. Sewage Works Ass'n, pp. 120-126.

H — *Municipal Sanitation*
6 — *May*
1. Brush Aeration Results at Activated Sludge Plant. By G. M. Ridenour and C. N. Henderson, pp. 136-140.
2. Incineration of Municipal Refuse. By H. W. Taylor, pp. 141-142, 157.
3. Performance of Flush Tanks in Sewer Flushing. By F. J. Taylor, pp. 143-144.

M — *Canadian Engineer*
6 — *April 30*
1. Drying Sewage Sludge on Vacuum Filters. By F. W. Jones, pp. 9-11.

May 14
2. Observed Earth Pressures on Deep Sewers in Tunnel. By C. R. Young and W. B. Dunbar, pp. 9-14.

P — *Public Works*
6 — *May*
1. Zooglea-Forming Bacterium Isolated from Activated Sludge. By C. T. Butterfield, pp. 15-16, 18.
2. Activated Sludge Plant at Springfield, Mo. By J. Williamson, Jr., pp. 19, 22.
3. Sewage and Industrial Waste Treatment at Waconia, Minn. By H. O. Halvorson and R. L. Smith, pp. 23-24, 26.

T — *Technique Sanitaire*
6 — *April*
1. Collection and Treatment of Waste Waters in Modern Abattoirs. By Rene Planchon and Dufournet, pp. 75-89.

II — *Public Works Engineers Yearbook*
6 — *Year 1935*
1. Sewage and Sanitation Developments. By L. R. Howson, pp. 112-117.
2. *c*. Sewer Tunneling in Glacial Drift. By N. I. Raymond, pp. 117-118.
3. Measurements of Flow in Sewers. By H. M. Dibert, pp. 145-146.

Eliminating Odors at Sewage Treatment Plants

PREVENTION of the dissemination of odors has been considered a matter of major importance at the sewage treatment plants of Johannesburg, South Africa. Various plans for effecting this were tried at that city's Bruma treatment works; and at the Delta works, now under construction and estimated to cost $500,000, $25,000 is being spent for this purpose. The expenditure of 5% of the cost of a plant for odor elimination is considered by the city to be thoroughly justified in many localities.

This subject was discussed by Harold Wilson, city bio-chemist of Johannesburg, in a paper before the Royal Sanitary Institute. He stated that not only odor prevention but also clarification was facilitated by adding coagulants and deodorants in the sewers themselves. For prevention of sulphide odors, the best method is to maintain a slightly alkaline condition throughout the entire sewerage and sewage treatment plant, which is cheaply and effectively secured by adding lime at key points in the sewerage system; use of chlorine gas also is strongly recommended. Prolonged and gentle agitation after adding a coagulant is necessary to permit the mineral floc to remove by absorption the maximum amount of impurities in the sewage, and this is obtained by the flow of the treated sewage down the sewers. (But the floc will be broken if agitated violently, as by pumping.) At the Johannesburg Eastern district, milk of lime is run into the sewer at a point 1¼ miles above the plant; no odors are generated, and the sewage when it reaches the plant has a very decided floc which settles readily in the tanks.

Mr. Wilson advises burning the screenings, or disintegrating them mechanically and passing them to a sludge digestor. The grit should be washed. The screens and disintegrators should be enclosed and the screenings never exposed to the air.

Preventing Odors During Sedimentation

For prevention of odors during sedimentation, he recommends the least possible surface exposure of the tank contents to the air, removal of sludge before it becomes septic, and immediate removal of scum as it forms. For this reason he prefers the hopper type (Dortmund) sedimentation tank, in spite of its greater cost and thinness of sludge removed. In his opinion, while traveling or revolving sludge and scum removers are helpful, they leave behind or stir up and carry around with the mechanism sufficient sludge to allow contamination of the freshly formed sludge, resulting in the formation of foul sludge and a foul-smelling effluent.

The enclosure of the screens, detritus tanks, sedimentation tanks and sludge well within a sealed building will confine the odors to that building; but the air from these and from sewage and effluent pipes can be deodorized in several ways. At the Bruma works a small brick building was erected over the sludge well and air drawn from this building was experimented with. One method was to utilize "the property which activated sludge possesses of absorbing almost immediately the smell from sewage with which it is mixed." The air intake of the air compressors which supply air to the activated sludge tanks was connected to the building over the sludge well and 600 cu. ft. of air per minute was drawn from it and passed through the diffusers. The air was very foul but was deodorized satisfactorily. However, this plan was not adopted as it was feared it would lower the efficiency of the activated sludge process.

Activated Carbon Use

Activated carbon scrubbers were used and found to deodorize the air very satisfactorily. A scrubber containing a quarter of a yard of activated carbon entirely removed the odor from ten million cubic feet of air, but the reactivating of the carbon presented a difficulty because the odor from the condensate had to be destroyed.

It was ultimately found that pressure ozonization was an effective and cheaper method of destroying odors, and a large building was erected over the clarifiers and sludge well and connected with the screen house. Ozonair apparatus has been installed in this building and the foul air is passed through this to the open air. This is the method that has been adopted for the Delta plant now under construction.

Chloramine for Algae Growths

In endeavoring to prevent algae growths in an open reservoir of the Perth, Scotland, water works, Cyril Walmesley, engineer and manager, tried the use of chloramine instead of the regular liquid chlorine dosage. Usually the ratio of 1 part ammonia to 5 of chlorine was used. When chlorine alone was applied to the water as it was pumped to the large distributing reservoir, all trace disappeared immediately on entering the reservoir; but with the ammonia added, an active residual can be maintained throughout the whole storage period (6 to 16 days) and throughout the distribution system also, and the resulting sterilization is more complete than with chlorine alone.

When the Wallace & Tiernan ammoniator was first installed in May a growth of asterionella was just commencing in the reservoir, but within a week it disappeared and has not been seen since. Growths of spirogyra used to rise in March around the margins of the reservoirs, but these are no longer seen. This result is obtained by maintaining a residual of 0.1 to 0.2 ppm. at the reservoir outlet.

About mid-summer the residual at the outlet began to disappear, and a minute green coccal form of alga made its appearance and multiplied rapidly. The incoming water at that time passed through an open inlet channel and over a weir into the reservoir, and this furnished considerable aeration, water falling over the weir carrying a constant stream of air bubbles into the reservoir. This dissipated much of the chlorine but left the ammonia in solution; the latter then no doubt assisting in the rapid multiplication of algae by supplying the necessary nitrates. Therefore the inlet channel was roofed over and a pipe substituted for the weir, which greatly improved conditions.

Chloramine, however, is an inhibitor of algae growth rather than an algaecide. Mr. Walmesley experimented with the addition of a trace of copper sulphate to the chloramine in water containing a heavy growth of synedra, with favorable results. In fact, he believes that such a combination might be more efficient than copper sulphate alone.

What's New?

99% Accuracy in Spreading:

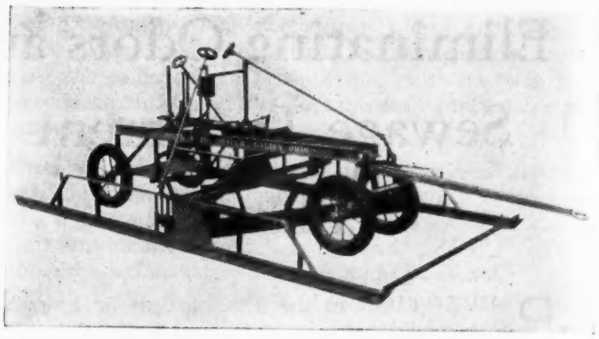
Recent demonstrations of a new machine for the spreading of all kinds of surfacing material, has shown, on a job where ½" mesh stone was to be spread at the rate of ten pounds per square yard in a strip 9 feet wide, a variation of only 500 pounds per mile, or less than 1% variation from absolute accuracy.

The accuracy with which this machine distributes definitely measured volumes of material is the result of the use of a spirally grooved feed roll that is driven through a reversing transmission, from the shaft supporting the wheels on which the spreader rides.

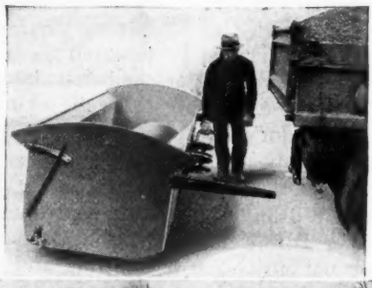
The volume of material is controlled by an adjustable shutter bar, and adjustment is easily accomplished while the spreader is in operation. In cases where graduated depth across the width of spread is desired, provision is made for building up the layer of material with one edge of the spread practically nothing, and the other side ranging in depth up to as much as 1½" thickness. The machine is coupled by a simple device, and may be unhooked from one empty truck and attached to the next loaded truck in a moment.

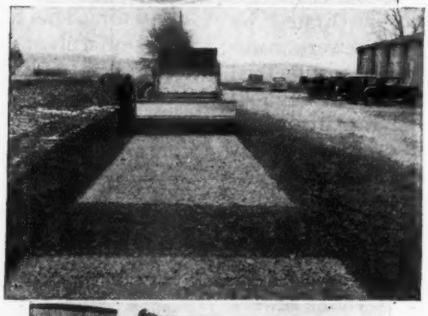
The spreader works equally well with the truck moving forward or in reverse.

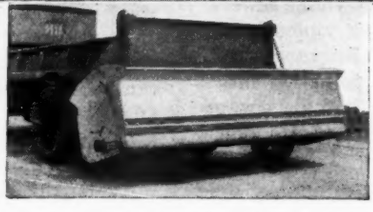
Because of the unusually accurate work done by the machine, it is adaptable to a wide variety of jobs, such as the spreading of sand on icy roadways, calcium chloride for traffic bound roads, etc. Write the Buckeye Traction Ditcher Company, of Findlay, Ohio, for complete information.



Right: The Gledhill road shaper operates well at 35 miles an hour.







Above: The Buckeye spreader is suitable for all kinds of spreading jobs.

Road Maintenance At 35 Miles an Hour

The Gledhill road shaper levels traffic-bound and similar surfaces effectively at 35 miles an hour. It is said to operate most efficiently at the higher speeds.

This is a medium weight, low-cost machine, which is a well balanced load for a 1½-ton truck. Two blades set at opposing angles eliminate side draft. The straight edges, one on each side, keep blades true and even so that roads are shaped to a true level, with the bumps planed off and ruts and hollows filled, leaving a smooth and even surface.

For full details of this pneumatic-tired equipment, write E. C. Gledhill, Gledhill Road Machinery Co., Galion, Ohio.

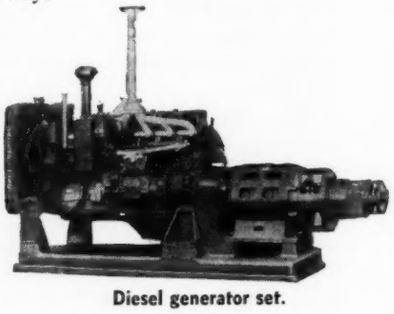
New Diesel Generator Set:

Joint announcement is made by the Harnischfeger Corporation of Milwaukee and the Caterpillar Tractor Company of Peoria, Illinois, of a co-operative arrangement for building Diesel powered "Harnischfeger-Caterpillar" generator sets.

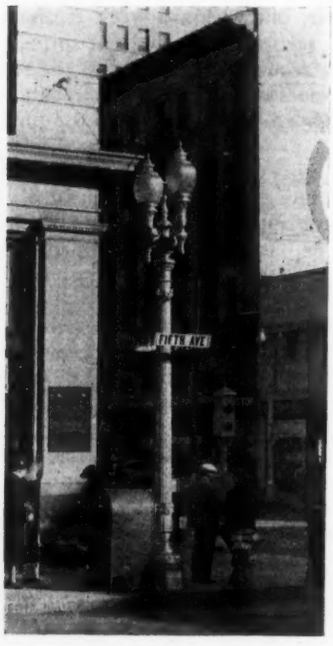
Capacities range from 35 to 60 kw, AC and DC. Suited for service in mines, quarries, construction camps, municipalities, etc. Generators are of the single bearing type directly connected by link coupling to the Diesel engine and mounted on a substantial cast iron base. Illustrated herewith is a 50 kw Alternator with mounted exciter.

The standard unit will include the engine with all auxiliaries, radiator cooling system, starting engine, auxiliary fuel pump, engine controls to provide proper speed setting and close governing, coupling between engine and generator, flywheel and coupling guard and the generator mounted on the unit base.

The electrical generator units, manufactured at Milwaukee, are shipped to the Caterpillar plant at Peoria for final assembly. Production is already under way.



Diesel generator set.



The "Visible" sign.

To Find the Way Better:

Continuous readability, regardless of hours or weather conditions, is a feature of a new type of street-name signs which will greet visitors to the California Pacific International Exposition, which opened May 29 at San Diego.

The lettering shown in the illustration is only five inches high, by thirty inches long, and the translucent shatterproof glass in which the letters are laminated makes the sign appear fully one-third larger than it is.

The frames and support are of a special formula of aluminum alloy, light, strong, and rust-resisting. The sign requires no additional electric current.

The sign is the invention of a Chicago woman who, as a physician's wife, learned the vital importance of finding patients' homes speedily, both night and day. She is Helen Converse Gatchell, former Shakespearian actress. For fuller information write Visible Night and Day Street-Name Signs, Inc., Monadnock Block, Chicago, Ill.

for best results..use Tar... FOR MIXED-IN-PLACE

Applying Tarmac P.

Mixing the mulch with blade grader.

Leveling the mix with a maintainer.

Applying cover material over seal coat of hot tar.

The finished Tarmac surface one year after construction.

mixed-in-place (graded aggregate type)

Mixed-in-place construction consists of two types:

1. Mulch treatment or graded aggregate type.
2. Coarse aggregate type.

Recent changes in the grades of tars used in various methods of road construction make it wise to review the situation.

1. Ordinarily, the mulch or graded aggregate type consists of a mixture of tar and aggregate graded from 1¼-inch down. The grade of tar selected depends upon the time of year the work is being done and the percentage of fine aggregate passing the 200 mesh sieve. For summer use, TM-2 (Tarmac P-6) should be used when the fines passing 200 mesh sieve are less than 3%. When 3 to 10% passes 200 mesh sieve, TM-1 or TM-2 (Tarmac P-5 or P-6) should be used. In cool weather it is advisable to use the next lighest grades of tar, such as TC-4 or TM-1. (Tarmac P-4 or P-5.)
2. The coarse aggregate type consists of tar and 1½-½ inch aggregate. For this type of aggregate, TM-2 or TH-1 (Tarmac P-6 or A-1) may be used in summer months, dropping to the next lighter grades of TM tar in the cooler months of spring and fall.

For plant mixes, the next heaviest grades of tar are used as shown in table.

For the seal coat, best results are obtained from the use of hot tar (TH) although TM tars may be used for this purpose.

Use the heaviest grades of tar possible without sacrificing workability of mix.

Type	*Grade of Tar for Summer Use*		*Gradation of Aggregate*
	Mixed-in-Place	Plant Mix	
Mulch Treatment or Graded Aggregate Type — Mixing Operation	TM-2	TH-1	1½" down—less than 3% passing 200 mesh sieve.
	TM-1 or TM-2	TM-2 or TH-1	1¼" down—3-10% passing 200 mesh sieve.
Mulch Treatment or Graded Aggregate Type — Sealing	TH-1 or TM-2	TH-1 or TM-2	⅜" chip preferable, but coarse sharp sand or pea gravel may be used.
Coarse Aggregate Type — Mixing Operation	TM-2 or TH-1	TH-1 or TH-2	1½—½"
Coarse Aggregate Type — Choke Seal	TH-1 or TM-2	TH-1 or 2	¾"—No. 8 Sieve
Coarse Aggregate Type — Seal	TH-1 or TM-2	TH-1 or 2	¾"—No. 8 Sieve

CONSISTENCY OF TARS
For Mixed-in-Place Construction

Proposed Standard Designations	Corresponding Tarmac Designations	Consistency: Spec. Vis. Engler 50cc @ 40°C.	Consistency: Spec. Vis. Engler 50cc @ 50°C.	Consistency: Float Test @ 32°C.	Application Temperatures
TC-4	P-4	25-35			80-150°
TM-1	P-5		16-22		80-150°
TM-2	P-6		26-36		80-150°
TH-1	A-1			60-150°	170-225°
TH-2	A-2			150-210°	170-225°

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Tarmac

mixed-in-place (coarse aggregate type)

Spreading coarse aggregate on base, previously widened and levelled with Mixed-in-place course using hot tar.

Applying Tarmac A (TH-1) to coarse aggregate.

Mixing hot tar (TH-1) with blade grader.

Rolling wearing course of Mixed-in-place surface.

After TH-1 seal coat, showing surface texture and built up shoulders.

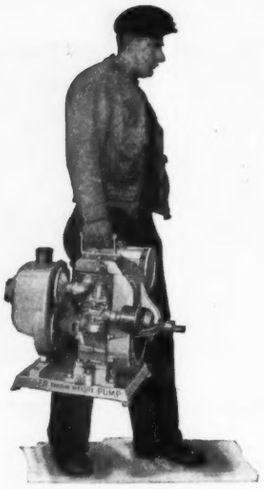
When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 51-53.

Handy Pumping Equipment:

Larger capacity and horsepower is available in this "Bantam Weight" pump developed by The Jaeger Machine Co., Columbus, Ohio. It is powered with 2½ hp. engine and rated at 8500 gallons per hour capacity.

Weight saving has been accomplished by compact design and the use of aluminum and alloy steel, producing an outfit which is also portable enough to be picked up with one hand, carried anywhere and set to work on anything from slow seepage to continuous, big volume pumping. It is excellent for general utility service to contractors, industrial users, public utilities and municipalities.

Priming action is completely automatic, without hand levers or adjustments. Repriming is also automatic to keep holes dry. With a tight suction line the "Bantam Weight" will remain primed for days. Patented self-cleaning shell design, open type impeller mounted direct on engine shaft and patented Lubri-Seal, which eliminates shaft packing, are other features.



Jaeger "Bantam" is easily carried.

For Better Concrete Work:

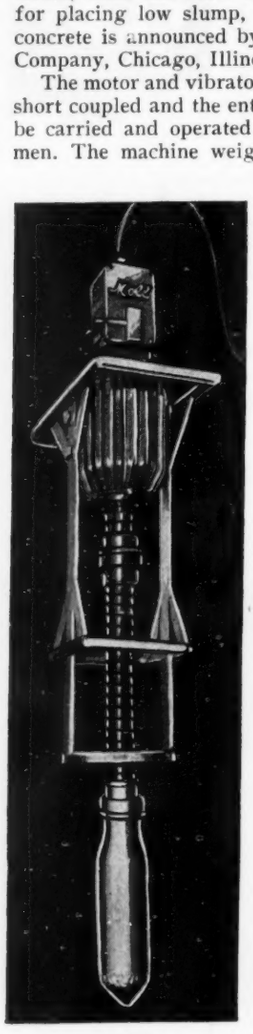
A new type electric combination internal, mass and form concrete vibrator for placing low slump, mass and form concrete is announced by the Mall Tool Company, Chicago, Illinois.

The motor and vibrator in this unit are short coupled and the entire machine can be carried and operated by one or two men. The machine weighs 140 pounds and the overall length is 5′ 6″.

As a flexible shaft vibrator the same motor can be utilized for vibrating concrete in forms or in places difficult to reach with the larger mass concrete vibrator. The motor can be used with either 14 ft., 21 ft., or 28 ft. of flexible shafting, depending upon the requirements in reaching the vibrator into the inaccessible points of the form.

Faster, more economical placement of stiff concrete mixes; denser, stronger, and more durable concrete; better bond between the concrete and reinforcing steel, and many other advantages are obtained when using vibrators for placing concrete.

Bulletins on this machine will be furnished upon request.



New Vibrator

New Three-Wheel Elevating Grader

This hydraulic power operated unit provides increased capacity, regardless of the ground worked, by a novel combination of weight distribution, elevator design, plow beam control and steering, according to The Austin-Western Road Machinery Co., Aurora, Ill.

By supporting the welded, one-piece, steel frame on three wheels, the weight of full loaded elevator is counterbalanced so that the 32-in. disc plow can be forced down and worked to maximum capacity. The elevator, driven at high speed by universal shaft, gets material away from plow as fast as it is dug.

To simplify operation, save gas and increase motor life, clutch and throttle controls are connected and synchronized. Throttle closes an instant after clutch is released and opens an instant before clutch is fully engaged.

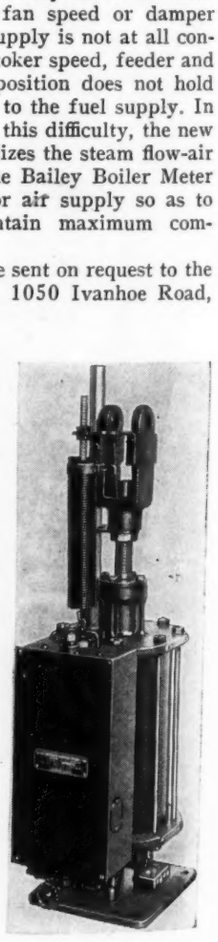
The new Austin-Western 3-Wheel hydraulic control elevating grader.

New Control Insures Combustion Economy

A new air-operated combustion control which automatically operates boilers to maintain steam pressure, furnace draft and maximum combustion economy has been developed by Bailey Meter Company. It places central station economy methods within reach of small industrial boiler plants, thereby making it possible for them to operate boilers economically and safely for long periods of time, reducing outage and maintenance.

The demand for steam is measured by variations in steam pressure and the rate of combustion is varied accordingly by the simultaneous control of fuel and air. This simultaneous control of fuel and air alone, however, does not insure the highest combustion economy since the relationship between fan speed or damper position and air supply is not at all consistent and since stoker speed, feeder and oil or gas valve position does not hold a definite relation to the fuel supply. In order to overcome this difficulty, the new control system utilizes the steam flow-air flow relation of the Bailey Boiler Meter to readjust fuel or air supply so as to continuously maintain maximum combustion economy.

Full data will be sent on request to the Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, O.



Bailey Control

The American Water Works Association

One of the finest technical conventions ever held was that of the American Water Works Association at Cincinnati, May 6 to 10. Measured by any standard, it was a real success. The total attendance was more than a thousand, and the official registration list exceeded 900. Entertainments and technical sessions alike were excellent.

Frank A. Barbour, of Boston, was elected president of the Association, succeeding Harry E. Jordan. W. W. Brush of New York was reelected treasurer. Chairmen of divisions were elected as follows: Management and Operation, W. W. Hurlbut, Los Angeles; Water Purification, A. E. Berry, Toronto; Finance and Accounting, Lewis D. Blum, New York. Linn H. Enslow was appointed director and chairman of the Committee on Publications, succeeding F. G. Cunningham, resigned.

Honorary membership was conferred on William F. Molis, superintendent of Waterworks of Muscatine, Ia., and on Dennis F. O'Brien of the A. P. Smith Co., East Orange, N. J. To Linn H. Enslow was awarded the John M. Diven medal for outstanding service to the association; to Dr. Frank E. Hale, director of Laboratories of the New York City Department of Water Supply, Gas and Electricity, was awarded the John M. Goodell prize for his paper on Pipe Corrosion experiments. The Virginia section won the N. S. Hill cup for percentage increase in membership, and the Montana section the Franklin Henshaw cup for attendance at meetings.

W. C. Sherwood of the Hersey Mfg. Co., South Boston, Mass., was elected president of the Water Works Mfrs. Ass'n. E. T. Fishwick of Worthington-Gamon Co., Newark, N. J., was reelected vice-president and E. J. Buttenheim was reelected treasurer.

A detour sign, one of the simple and low-cost line of signs and signals manufactured by the Martindale Electric Co., 1378 Hird St., Cleveland, Ohio.

The papers and discussion presented at the technical sessions were numerous, voluminous and excellent, covering well all branches of the water works field. Entertainment included the boat trip on the Ohio, the all-division dinner, the smoker and the dinner-dance.

Exhibits were generally above the average to be expected at conventions. Space was restricted, as is usually the case in a hotel housing a convention as large as this, but the quality of the materials shown more than overcome this handicap. The past year has been one of much development in the water works field, and most everyone was there with new stuff to show. Water works officials showed considerable interest in the displays and the exhibit hall was unusually crowded.

Pa. Water & Sewage:

The Pennsylvania Sewage Works Association will hold its annual meeting at State College, Pa., June 24-26. The full program of the meeting, which contains many interesting papers and discussions, can be obtained from L. D. Matter, Kirby Health Center, Wilkesbarre, Pa.

Just following this meeting will be the Pennsylvania Water Works Operators, which will be held June 26-28. The program of this meeting has not yet been received, but can be obtained by writing I. M. Glace, 506 S. Office Bldg., Harrisburg, Pa. As usual, this meeting also will be held at State College.

Southern Vitrified Pipe Association:

Frank E. Bone, Executive of the Oconee Clay Products Company of Milledgeville, Georgia, was elected president of the Southern Vitrified Pipe Association, to succeed J. M. Palmer of the Lee Clay Products Company of Clearfield, Kentucky, at the annual convention of the Association, held at the Henry Grady Hotel in Atlanta, Georgia, May 21, 1935. J. M. Clark of the Georgia Vitrified Brick & Clay Co., Augusta, was elected vice president.

The Association's headquarters will continue at 123 East Sixth Street, Cincinnati, Ohio, where it has been located since 1933.

Personals

Arthur T. Clark, formerly division superintendent of the Greenwich Water Company, has been recently appointed manager of the Morristown, New Jersey, water department.

Robert P. Trask has been appointed superintendent of public works in Lexington, Massachusetts.

Victor J. Mill of Baldwinsville, N. Y., has purchased the Lawrence Machine & Pump Co. of Lawrence, Mass., and will continue to operate it under the name of the Lawrence Machine & Pump Corp. This company, which was established in 1882, made the first centrifugal pump in the United States. The line will include centrifugal pumps, for a broad and varied field, notably single and multi-stage water pumps, stock pumps, sewerage and sludge pumps, slurry pumps, chemical pumps and sand and dredging pumps. In addition the plant will build hydraulic dredges and special machinery, a field in which Mr. Mill has had a wide experience.

Samuel B. Morris, chief engineer and general manager of the Pasadena water department and builder of the $7,600,000 Morris Dam, has been appinted professor of civil engineering, Stanford University, to succeed Professor J. C. L. Fish, who will retire emeritus at the end of the current academic year. Professor Morris was graduated from Stanford in 1911 with the A.B. degree in civil engineering, has been chief engineer of the Pasadena water department for the past 22 years, and is 44 years old.

The new Stanford professor conceived, designed, and had charge of the construction of the dam which was named in his honor. It is the principal unit of the San Gabriel River water project.

H. P. Chapman, formerly assistant director and chief engineer of the Ohio Highway Department, and Charles K. Bradley have announced the formation of the firm of Chapman & Bradley, attorneys at law, registered professional engineers, 30 East Broad St., Columbus, Ohio.

Augustus W. Jones, for thirteen years field representative of the Kentucky Rock Asphalt Company in Pennsylvania, Maryland and Delaware, died May 7th at his home in Chilicothe, Ohio, following an illness of only a few days.

Material Prices

(Published for information only)

(May 24, 1935)

Warehouse Prices on Reinforcing Steel and Structural Shapes

	Structural Shapes	*Reinforcing Bars*
New York	3.37c	3.26
Boston	3.20	3.00
St. Louis	3.44	3.24
Cincinnati	3.42	3.25
Pittsburgh	3.15	3.05
Chicago	3.20	2.60
Philadelphia	2.98	2.93
Cleveland	3.31	2.10
San Francisco	3.55	2.45

Prices on cast iron pipe, net per ton, Class B, 6-inch and larger, AWWA specifications*

Boston	$47.50	Baltimore	$45.50
New York	44.90	Atlanta	42.00
Chicago	46.00	Birmingham	38.00
Minneapolis	48.50	Kansas City	48.15

Burlington, N. J., $42.00; extra price for 4-inch, $3.00 per ton; extra for Class A, $3.00 per ton

**Information, courtesy U. S. Pipe & Foundry Co.*

Warehouse Prices on American Pig Lead

Per pound

New York	4.25
Cleveland	4.10

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Pedestrian Hazard
• • •
3 inch Sunken Walk Slab

Hazard Eliminated
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Slab Raised to Grade

Corrects Sunken Sidewalk Slab

One of many applications of the Mud-Jack method is the raising of sidewalk slab—the No. 10 N. E. C. MUD-JACK corrected the 3-inch settlement illustrated, in less than TEN MINUTES. Compare this with slab replacement costs. Depressed curb, gutter and street slab is quickly and efficiently raised to the correct grade by this modern economical method.

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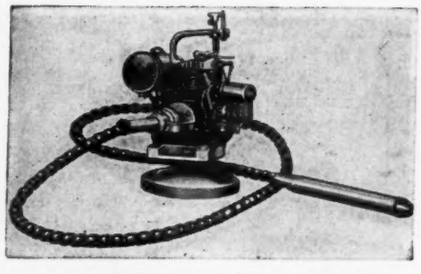

Mall 2 h.p., 3600 RPM Gasoline Engine Concrete Vibrating Machine with Automatic Clutch and 2¾"x18" Vibrator. Can be furnished with 14 ft., 21 ft. or 28 ft. of Flexible Shafting. Also units for operation up to 6000 rpm. Attachments Available for Concrete Surfacing.

Mall

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